Natural Gas Industry Number

66.

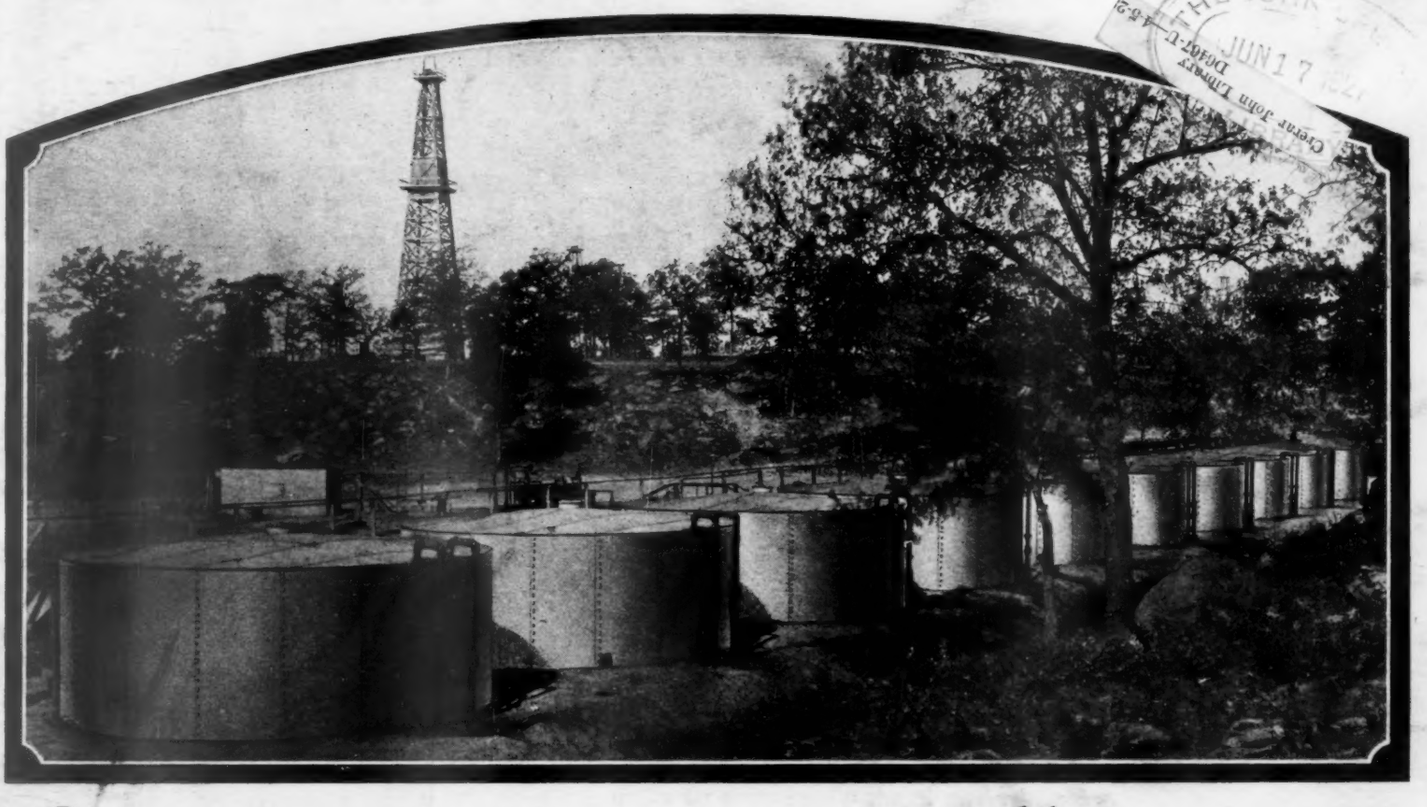
15 Cents a Copy

The OIL and GAS JOURNAL

PRODUCING REFINING MARKETING

Published Every Thursday TULSA, OKLAHOMA, JUNE 16, 1927 $6.00 a Year

THE JOHN CRERAR LIBRARY JUN 17 1927 Chicago



Conserve *GAS* as well as *OIL*

Ability to conserve valuable gas, which can be taken off and utilized by gasoline plants, is just another asset offered by MALONEY Tanks.

Decks, like sides, are 100% gas-tight—a result of our patented crimp and heavy channel reinforcement of seams, our special packing and Gaso Cement, and the heavy ladder and rafter deck supports. Vacuum-pressure valve equipment is the best available, with accurate, gas-tight valve seats.

MALONEY special pearl-gray paint, which deflects light and heat—is another important factor in reducing evaporation to the absolute minimum.

All MALONEY Tanks are constructed of Keystone Copper Steel, the most highly rust-resisting sheet steel. The battery shown above is constructed throughout of 12-gauge sheets. This battery is on the Cudjo Farm of Tom Slick, Inc., Seminole.

12 to 3,000 Bbls. Capacity

MALONEY TANK MFG. COMPANY
Tulsa, Okla., U. S. A.
Distributors at All Principal Petroleum Points

Packed in Steel-Bound Crates for Export

MADE OF KEYSTONE COPPER STEEL

Howell Aluminum "3-in-1" Vacuum-Pressure Valve and Thief Hatch—The BEST and LATEST Deck Equipment—POSITIVE Safety

MADE OF KEYSTONE COPPER STEEL

MALONEY

MALONEY PATENTED BOLTED COPPER-STEEL TANKS

Advertisers' Index on Page 33

Table of Contents on Page 34

cuts rock quicker...

why?

BECAUSE each set of cutters works at a different angle to *c-h-i-p* (not chew or grind!) at the rock. Because the cross-roller cutters, all of the same diameter, turn on an eccentric bushing—which lowers them and gives amplest clearance *under* the head, where it is so often needed. And because this model deals as surely with semi-hard formations, as with hard rock. Quicker? Of course it's quicker. It's built to be quicker.

Reed MODEL 26

SEE IT HERE WITH A REAMER COLLAR

Screw on a Model 26 Rock Bit with Reamer and go right on down making a hole straight, round, smooth-walled and full gauge, ready for setting casing without the least trouble. Suppose you write in for more particulars?

REED ROLLER BIT COMPANY

HOUSTON **LOS ANGELES**

The OIL and GAS JOURNAL

PRODUCING REFINING MARKETING

VOL. 26 NO. 4 TULSA, OKLAHOMA, JUNE 16, 1927

Copyright, 1927, by The Petroleum Publishing Co.

TABLE OF CONTENTS

SPECIAL ARTICLES

Index for Natural Gas Industry Insert 31

Production Declines 13,249 Bbls. 35
By James McIntyre
California the only division showing marked increase, due to spurt of the Seal Beach Pool. Decline in drilling.

Crude Small Factor in Gasoline 37
By L. M. Fanning
Represents less than one-fourth price at filling station. Other costs do not fluctuate.

Problems in Overproduction of Oil 38
By E. W. Clark
President of American Petroleum Institute addresses standardization conference.

Standardization Conference at Colorado Springs 38
By A. M. Rowley

Efficacious Use of Core Drilling 39
By J. L. Dwyer
After surface-structure geology failed, the core drill made good in a joint operation in Oklahoma.

President Skelly Gives Exposition Board's Views 39

Principles of the Air and Gas Lift 40-41
By S. F. Shaw
All phases of this important subject explained and formulas furnished by expert.

Magnolia Line Has Many New Features 42
By James H. Dameron
Large diameter telescopic and continuous welded line proves highly successful.

Gasoline and Crude Prices (Editorial) 44

Oil "Joker" in Arms Limitation Pact 46
By Charles E. Kern
United States may seek revision of clause on oil storage in Philippines at Geneva.

Natural Gas Industry Insert Begins Opposite Page 40

A. P. I. to Create Accounting Division 321
By L. M. Fanning

New Natural Gas Organization 363
By Neil Williams

FIELD OPERATIONS

North and West Texas 47
By C. D. Lockwood

Late Fields 47

Texas Panhandle 48
By James H. Dameron

Oklahoma 50
By J. L. Dwyer

Mexico 50
By George Blardone

Kansas 52
By J. L. Dwyer

Southwest Texas 54
By B. D. Stevenson

North Louisiana-Arkansas 56
By Neil Williams

Artesia, New Mexico 56
By Special Correspondent

East Central Texas 57
By Special Correspondent

Gulf Coast 61
By P. L. McGreal

Farmington, New Mexico 61
By Special Correspondent

Rocky Mountain Area 62
By Frank B. Taylor

Canada 62
By Victor Lauriston

California 64
By L. P. Stockman

Pennsylvania-West Virginia 65
By D. S. Wakenight

Central West 65
By Whit

Kentucky-Tennessee 66
By Whit

Michigan 66
By Whit

REFINING AND MARKETING

Little Activity in Oklahoma Market 36
By C. O. Willson
Demand dull for practically all products. Natural gasoline and kerosene again lowered. Refinery gasoline unchanged.

Chicago Market Opens Week Quiet 350
By J. B. Waldo

Gasoline in East at Bottom Prices 351
By N. O. Fanning

Sulphur Compounds in Mineral Oils 352
By P. Borgstrom and E. Emmett Reid
Review of discoveries given as basis for further research to determine reactions.

Refining and Marketing News 354

Plant Operators' Page 355

Refinery and Crude Prices 356-357

Tank Wagon Quotations 358

Trend in Distillate Market Uncertain 362
By Neil Williams
Heavy stocks and cracking complicate situation in North Louisiana-Arkansas.

Technical Questions Answered 368
By Dr. C. K. Francis

Laboratory in Refinery Operations 370
By C. O. Willson
Marland plant has separate building with complete equipment for testing.

ARTICLES OF GENERAL INTEREST

The Advertisers' Index 33

Natural Gas Developments 72

Men Known in Oildom and Personals 74

Equipment and Supplies 78

Pipe Order for Denver Gas Line Reported 334
By B. E. V. Luty

Classified Want Advertisements 348-349

Oil Securities Strong and Active 360
By N. O. Fanning

Crude Petroleum Statistics 400

BE A REGULAR READER

The OIL and GAS JOURNAL Tulsa, Okla.

You are hereby directed to mail The Oil and Gas Journal to me for.....year. Enclosed find remittance $.....

Classify my interests as checked by me.

.....Producing .....Refining
.....Equipment .....Marketing

Name .....
Address .....
City .....

$6 a Year
$3 6 Months

Refinery Section Starts on Page 350

The ADVERTISERS' INDEX

A

Acme Fishing Tool Co. 383
Ajax Iron Works 58-59
Ajax Rope Co. 397
Allegheny Steel Co. .....
Aluminum Co. of America .....
Amarillo Hotel 397
American Asphalt Paint Co. .....
American Cable Co., Inc. .....
American Car & Foundry Co. G-184
American Manganese Steel Co. .....
American Radiator Co. .....
American Roller Bearing Co. 381
American Rolling Mill Co. .....
American Schaeffer & Budenberg Corp. .....
American Sheet & Tin Plate Co. .....
American Spiral Pipe Works .....
American Telephone & Telegraph Co. ...
American Well Works .....
Anderson Engine & Foundry Co. .....
Andrews Steel Co. 322
Arco Company, The 5
Armstrong Bros. Tool Co. 399
Association of Natural Gasoline Mfgrs. 18
Athey Truss Wheel Co. .....
Auer, C. A. .....
Austin Co. 327
Axelson Machine Co. 71

B

B. & A. Specialty Co. 330
Baash-Ross Tool Co. .....
Babcock & Wilcox Tube Co., The .....
Baker Casing Shoe Co. 22
Barber Asphalt Co. .....
Barber-Greene Co. G-169
Barco Manufacturing Co. 336
Barnickel, Wm. S., & Co. 398
Barnsdall Refineries, Inc. .....
Barrett, G. E., & Co. G-45
Bartlesville Supply Co. 329
Beaumont Iron Works Co. .....
Becker Specialty Co. .....
Bessemer Gas Engine Co. G-20, G-21
Bethlehem Steel Co. 60
Biggs Boiler Works Co. G-225
Bignall & Keeler Machine Works 377
Blackmer Pump Co. 385
Blaw-Knox Co. .....
Borden Co. .....
Bovaird & Seyfang Mfg. Co. .....
Bovaird Supply Co., The 12-13
Braden Steel & Winch Co. .....
Braun, C. F., & Co. 369
Broderick & Bascom Rope Co. 16
Bridgeport Machine Co. 7
Bristol Co. G-167
Brooks Engineering Corp. .....
Brown, Arthur C. 399
Brown Instrument Co. 62
Brownell Co. 398
Buckeye Traction Ditcher Co. G-176
Buda Co. .....
Buffalo Bolt Co. .....
Buffalo Gasolene Motor Co. .....
Bullock, Henry E. .....
Burns Tool Co. .....
Burt Corp. .....
Burt Mfg. Co. 346
Butler Mfg. Co. G-40
Byron Jackson Pump & Mfg. Co., Inc. 4

C

Cameron Iron Works 374
Campbell, J. A. 334
Canadian Pacific Railway Co. .....
Carbondale Machine Co. .....
Celite Products Co. .....
Central Alloy Steel Corp. .....
Central Forging Co. .....
Central National Bank of Tulsa G-191
Central Tube Co. G-201
Chain Belt Co. .....
Champion Machine & Forging Co. .....
Chaplin-Fulton Mfg. Co. 396
Chapman Valve Mfg. Co. G-31
Chestnut & Smith Corp. .....
Chicago Bridge & Iron Works 69
Chicago Pneumatic Tool Co. 344
Chicago Tribune 392
Chisholm-Moore Mfg. Co. 386
Clark Brothers Co. G-146, G-147
Classified Wants 348-349
Cleveland Trencher Co., The G-46
Climax Engineering Co. .....
Coen Company, The G-64
Columbian Rope Co. .....
Columbian Steel Tank Co. .....
Columbus Forge & Iron Co. .....
Connersville Blower Co., The G-220
Continental Motors Corp. .....
Continental Supply Co. 32, G-81, G-82, G-83, G-85, G-86, G-87, G-89, G-91.
Cook Motor Co., The .....
Cooper, C. & G., Co. 80, G-92, G-93
Crane Co. G-100, G-101, G-102, G-103
Crane Packing Co. .....
Crescent Belt Fastener Co. .....
Crown Central Petroleum Corp. .....

D

D. & B. Pump & Supply Co. .....
Darling Valve & Mfg. Co. .....
Dart, E. M., Mfg. Co. .....
Davis, G. M., Regulator Co. G-50
Dayton Pipe Coupling Co. .....
Dearborn Chemical Co. G-192, G-193
De La Vergne Machine Co. .....
Delta Electric Co. 398
Detex Watchclock Corp. .....
Detroit Graphite Co. .....
Diamond Drill Carbon Co. 396
Dixon, Joseph, Crucible Co. .....
Dodge Mfg. Co. .....
Donovan Boiler Works, Inc. .....
Dresser, S. R., Mfg. Co. 45, G-2, G-3
Dunn Mfg. Co. 49
DuPont de Nemours & Co., Inc., E. I. .....
Duriron Company, The .....

E

Eagle-Picher Lead Co. .....
Eastern Torpedo Co. .....
Eclipse Paint & Mfg. Co. G-172
Edward Valve & Mfg. Co. .....
Ejecto Company, The G-231
Elliott Core Drilling Co. 378
Empire Gas & Fuel Co. G-70
Empire Refineries, Inc. .....
Emsco Derrick & Equipment Co. .....
Equitable Gas Co. G-163
Ethyl Gasoline Corp. .....
Exchange National Bank G-53
Exner-Dodge Packer Co. G-164

F

Fairbanks-Morse & Co. .....
Federal Supply Co. .....
Fenwick-Reddaway Mfg. Co. G-211
First National Bank of Tulsa G-199
Fisher Governor Co. G-28, G-29
Fluor Construction Co. .....
Foamite-Childs Corp. .....
Fohs, F. Julius .....
Foos Gas Engine Co. .....
Ford, Bacon & Davis, Inc. G-150
Ford Chain Block Co. 388
Foxboro Co., Inc., The G-152, G-153
Franklin Valveless Engine Co. 66-67
Frick-Reid Supply Co. G-160

G

Gallagher Co. .....
Gardiner, J. W. B., Inc. G-78
Gardner Governor Co. 347
Garlock Packing Co. G-96
Gasoline Recovery Corp. 7
Gaso Pump & Burner Mfg. Co. ..... Inside Back Cover
General American Tank Car Corp. .....
General Asbestos & Rubber Co. .....
General Electric Co. 379
General Insulating & Mfg. Co. .....
Gilbert & Barker Mfg. Co. 395
Gilfillan Machine Works .....
Goodrich, B. F., Rubber Co. G-233
Goodyear Tire & Rubber Co. .....
Gott, H. P., Mfg. Co. 396
Goulds Pumps, Inc. G-108
Graham Brothers .....
Graver Corp. 328
Gray Processes Corp. .....
Greenspon's, Joseph, Sons, Iron & Steel Co. G-231
Griscom-Russell Co. 332
Gulberson Corp. 28
Gulf Refining Co. .....
Gustin-Bacon Mfg. Co. .....

H

Halliburton, Erle P., Co. .....
Halliburton Oil Well Cementing Co. .....
Harrisburg Pipe & Pipe Bending Co. ...
Haynes Stellite Co. .....
Hazard Mfg. Co. .....
Henderson, W. K., Iron Works & Supply Co. G-203
Heppenstall Forge & Knife Co. .....
Hercules Motors Corp. .....
Hercules Tool Co. 384
Heydrick Mapping Co. 399
Hill, Hubbell & Co. G-36, G-37
Hills-McCanna Co. 20
Hinderliter Tool Co. .....
Homestead Valve Mfg. Co. .....
Hoover Steel Ball Co. .....
Hope Engineering & Supply Co. G-59, G-60, G-61, G-62
Hopkins, Edwin B. 399
Hotel Coronado .....
Hough, Charles N., Mfg. Co. G-209
Houston Pipe Line Co. G-136
Hoyt Metal Co. .....
Hughes Tool Co. ..... Back Cover
Humble Oil & Refining Co. .....
Hunt, Robert W., Co. G-239

I

Imperial Belting Co. 390
Imperial Brass Mfg. Co., The G-239
Imperial Royalties Co. 399
Indiana Truck Corp. .....
Industrial Construction Co. G-67
Ingersoll-Rand Co. G-123
International Derrick & Equip. Co. 324-325
International Harvester Co. of America. .....
International Nickel Co. .....
International Supply Co. .....
Interstate Gasoline Co., Receivers for .. 398

J

Jarecki Mfg. Co. 387
Jefferson Union Co. .....
Jensen Brothers Mfg. Co. .....
Johns-Manville Corp. G-69
Jones, J. Edward 397
Jones, S. M., Co. 331

K

Kansas City Hay Press Co. .....
Kaw Steel Construction Co. 27
Kellogg, M. W., Co. 339
Kelly, John Eoghan 399
Kennedy Valve Mfg. Co. G-77
Kerotest Mfg. Co. G-145
Keuffel & Esser Co. .....
Kinley, M. M., Co. .....

L

Lamport, A. M., & Co., Inc. G-229
Landis Machine Co. G-240
Larkin & Co. G-118
Layne & Bowler Co. 335
Leader Iron Works .....
Leidecker Tool Co. .....
Leschen, A., & Sons, Rope Co. G-117
Lientz, B. P., & Co. 10
Lincoln Electric Co. .....
Linde Air Prdoucts Co. 1
Link-Belt Co. .....
Lone Star Gas Co. G-54
Longyear, E. J., Co. 380
Lubrikup Co. .....
Lucas, John & Co., Inc. .....
Lucey Mfg. Corp. .....
Ludlow Valve Mfg. Co. G-111
Lufkin Fdy. & Machine Co. .....
Lufkin Rule Co. .....
Lunkenheimer Co. 11

Mc

McCord Radiator & Mfg. Co. G-33, G-236, G-237
McGregor Working Barrel Co. 397
McIntosh & Seymour Corp. .....
McKee, Arthur G., & Co. .....

M

Madison Kipp Corp. .....
Magnolia Petroleum Co. .....
Maloney Tank Mfg. Co. ..... Front Cover
Manzel Brothers Co. .....
Marsh Gauge Pole Co. 397
Mason Regulator Co. 341
Master Builders Co. .....
Mathieson Alkali Works, Inc. .....
Maverick, Phillip 399
Merco Nordstrom Valve Co. 76-77
Merit Oil Equipment Co. .....
Metric Metal Works G-4, G-5
Mid-Continent Oil & Gas Ass'n., The .. G-127
Midwest Piping & Supply Co. G-155
Miller Improved Gas Engine Co. G-39
Miller, Max B., & Co., Inc. .....
Mine Safety Appliance Co. .....
Mission Sales Co. .....
Modern Engineering Co. G-195
Moon Mfg. Co. G-228
Moore, Lee C., & Co., Inc. ..79, G-156, G-157
Moran Furnace & Sheet Metal Co. G-164
Multi Metal Co. G-159
Munn & Co. 399
Myers, F. E., & Bro., Co. 399

N

National Carbon Co., Inc. 1
National Lead Co. 23
National Petroleum Engineering Co. 397
National Supply Co. G-120, G-121
National Transit Pump & Machine Co. 55
National Tube Co. 2
National Turnbuckle Derrick Co. .....
Neilan Shumacher & Co. 393
Newton Process Mfg. Co. 43
Norris Brothers, Inc. 382
Norris, W. C. G-112
North American Car Corp. .....
Northern Fire Apparatus Co. 19
Northwest Louisiana Gas Co., Inc. G-239
Novo Engine Co. .....
Nuttall, R. D., & Co. G-219
Nye Tool & Machine Works .....

O

Oakite Products, Inc. 372
O'Brien Steel Construction Co. .....
Ohio Injector Co., The .....
Ohio Steel Foundry Co. .....
Oil City Iron Works .....
Oil Conservation Engineering Co. .....
Oil Country Specialties Mfg. Co. 29
Oil Insurance Association .....
Oil Well Accessories Co. .....
Oil Well Supply Co. 75
Oklahoma Contracting Co. G-124
Oklahoma Gas & Electric Co. .....
Oklahoma Natural Gas Corp. G-183
Oklahoma Portland Cement Co. .....
Ouachita Natural Gas Co., Inc. G-195
Oxweld Acetylene Co. 1

P

Page Steel & Wire Co. .....
Paige & Jones Chemical Co., Inc. .....
Palmer Corp., The G-203
Parkersburg Machine Co. 345
Parkersburg Rig & Reel Co. 8
Patrick, R. S. 388
Pattin Brothers Co. G-135
Pelican Well Tool & Supply Co. .....
Penberthy Injector Co. 390
Petroleum Appliance Co. 24
Petroleum Iron Works Co. 389
Pforzheimer, Carl H., & Co. G-227
Phillips Petroleum Co. .....
Pittsburgh-Des Moines Steel Co. .....
Pittsburgh Equitable Meter Co. G-129, G-130, G-131, G-132
Pittsburgh Steel Products Co. .....
Pilbrico Jointless Firebrick Co. .....
Powell, William Co. .....
Power Mfg. Co. 396
Power Piping Co. G-34
Power Plant Equipment Co. .....
Power Specialty Co. 371
Prescott Co., The 1
Prest-O-Lite Co., Inc., The .....
Pure Oil Co. .....
Pyle-National Co. .....

Q

Quaker City Rubber Co. 399

R

Ratigan, J. P., Co. .....
Reading Iron Co. 15
Reading Steel Castings Co., Inc. .....
Reed Roller Bit Co. ..... Inside Front Cover
Regan Forge & Engineering Co. 25
Reid, Joseph, Gas Engine Co. G-6
Republic Iron & Steel Co. .....
Republic Supply Co. 6
Reserve Natural Gas Co. G-227
Reynolds Gas Regulator Co. G-95
Ridge Tool Co. G-235
Riehle Bros. Testing Machine Co. .....
Riter-Conley Co. 399
Robinson Orifice Fitting Co. .....
Rock Island Plow Co. .....
Roots, P. H. & F. M., Co. G-56
Ross-Meehan Foundries .....
Roth & Faurot G-239
Ryerson, Joseph T., & Sons, Inc. 398

S

Safety Gas Main Stopper Co. G-167
Safety Pulling Machine Co. .....
Shaffer, J. E., Co. .....
Shaffer Tool Works .....
Shaw, S. F. .....
Sheffield Steel Corp. 395
Sinclair Refining Co. 359
Sivyer Steel Casting Co. 343
Skelly Oil Co. .....
Skinner, M. B., Co. G-191, 399
Smith, A. O., Corp. 17, G-212, G-213
Smith Separator Co. G-14, G-15
Smooth-On Mfg. Co. 340
Sonner, P. J., Gas Burner Co. G-179
South Chester Tube Co. .....
Southern Cornice Works .....
Southern Mill & Mfg. Co. G-199
Southwestern Engineering Corp. 323
Spang & Co. G-216
Spang, Chalfant & Co., Inc. 30
Spence Machine Co. .....
Spencer Trailer Co. .....
Standard Rail & Steel Co. G-227
Stanley Belting Corp. .....
Star Drilling Machine Co. .....
Stearns-Roger Mfg. Co. .....
Steiner, George 397
Strom Steel Ball Co. .....
Sullivan Co., The 333
Sullivan Machinery Co. G-175

T

Taubman Supply Corp. G-222, G-223
Taylor Instrument Companies 376
Templeton, Kenley & Co., Ltd. .....
Texas Company, The 373
Texas Pacific Coal & Oil Co. .....
Texas Steel Co. G-149
Timken Roller Bearing Co. 9
Tips Engine Works .....
Titusville Forge Co. .....
Titusville Iron Works 21
Toledo Pipe Threading Machine Co. G-105
Trimont Mfg. Co. 375
Trumble Gas Trap Co. .....
Tulsa Iron Works Co. G-171
Tulsa Pipe & Supply Co. of Texas G-228
Tulsa Sheet Metal Co. .....
Turk & Mauldin 399
Twin Disc Clutch Co. .....

U

Union Gas Corp. G-215
United Iron Works, Inc. .....
United States Cast Iron Pipe & Fdy. Co. G-49
United States Industrial Diamond Corp. .399
Universal Oil Products Co. 51
U. S. Tool Co. .....

V

Victaulic Co. of America G-139
Victor Balata & Textile Belting Co. ..394
Vogt, Henry, Machine Co. .....

W

Wagner Electric Corp. 393
Walles Dove-Hermiston Corp. G-72, G-73
Walker, A. H., & Co. G-188
Wall Rope Works, Inc. .....
Walsh & Weidner Boiler Co. .....
Walworth Co. 58
Ward Chemical Co. G-175
Washburne, Chester W. 399
Ward, Gruver & Co. 397
Waukesha Motor Co. .....
Westcott & Greis G-204, G-205
Westinghouse Electric & Mfg. Co. .....
Wheelton & Townsend, Inc. .....
Wheeler Condenser & Engineering Co. ...
Wheeling Steel Corp. 73
White Company, The G-74
Wickwire Spencer Steel Co. .....
Wico Electric Co. .....
Widdell Engineering Co. .....
Williams, J. H., & Co. .....
Williams Brothers, Inc. G-215
Williamsport Wire Rope Co. G-180
Williams Tool Corp. 396
Wilson Oil Tools Corp. .....
Wilson-Snyder Mfg. Co. 26
Witte Engine Works 394
W-K-M Company, Inc. G-142, G-143
Worthington Pump & Machinery Corp. G-115
Wright Mfg. Co. .....

Y

Yale & Towne Mfg. Co. .....
Young Engine Corp. G-207

Z

Zero Hour Torpedo Co. 391
Zwetsch, Heinzelmann & Co. G-175

Production Declines 13,249 Barrels

Highest daily average estimated production in 1926, week ended Dec. 25, 2,385,139 bbls. Lowest in 1926, January 30, 1,915,960 bbls.

California the Only Division Showing Marked Increase, Due to Spurt of the Seal Beach Pool. Decline in Drilling

By James McIntyre

Highest daily average estimated light oil production in 1926, week ended Dec. 25, 1,797,349 bbls. Lowest in 1926, Jan. 30, 1,371,600 bbls.

Crude oil production in the United States declined materially in the week ending Saturday, June 11, falling to 2,492,564 barrels a day, or 13,249 barrels per day below the average for the previous week. California was the only producing division that showed an increase. The Seal Beach Field increased from 54,000 barrels a day to 65,000 barre's a day due to the completion and deepening of 11 wells, and Californ'a's production increased from 634,000 barrels to 645,000 barrels.

The Seminole Pool in Oklahoma showed an increase of 1,925 barrels but the total production of Oklahoma was 1,215 barrels below the figure for the week before. The production of Texas took a decided drop, every producing division showing some decline. The Rocky Mountain area also experienced a decided decline.

Oil men and petroleum economists who have made a study of the Seminole Field are of the opinion that the peak in that field is close at hand and no one any longer believes that Seminole will ever hit the 400,000-barrel mark. There was a time when Seminole was looked upon as a probable 450,000-barrel field, but this figure is hardly possible if the conservative development of the wildcat areas in the 576,000-acre Seminole Field is continued.

Outside of the new production in Seal Beach the reviews of field operations in the United States contained little of a sensational character. Plainly field operations are falling off almost everywhere. The industry has settled down to a stage where it is waiting for the oil surplus to spend itself before indulging in an even normal amount of drilling. Conservative operating methods in the new and prolific fields are holding back some of the flood of crude the country is capable of producing, which is the principal reason why the production for the past few weeks has not steadily mounted.

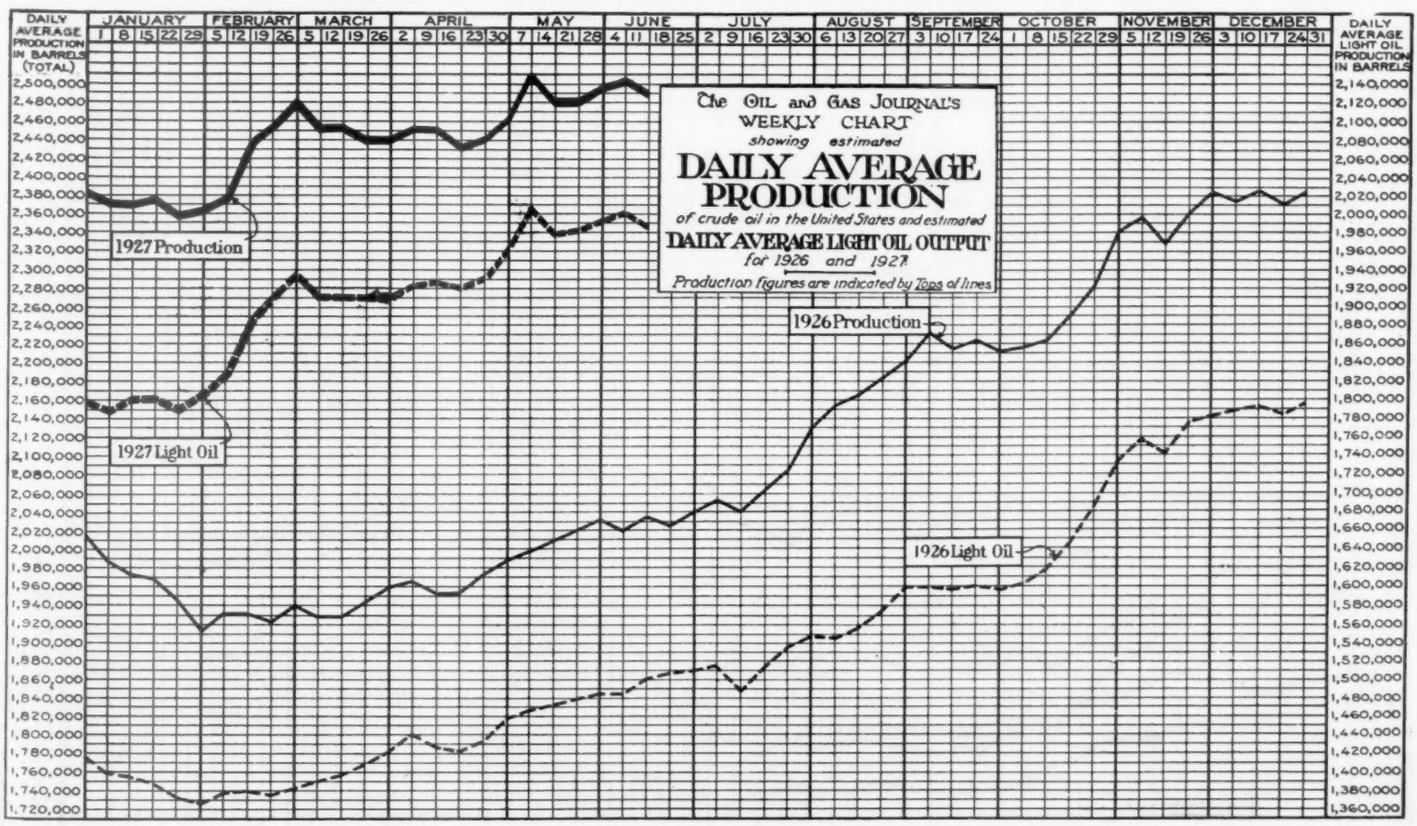
There is a better feeling among producers in the Kansas-Oklahoma area. The quantity of crude being run to storage in those two States has been falling off of late until it has settled back to about 60,000 barrels a day and there appears to be no reluctance on the part of the crude buyers to make new pipe line connections.

PRODUCTION IN THE UNITED STATES

Estimated daily average production of light and heavy gravity oil in the United States for week ended June 11, and a comparison with the previous week folows:

	June 11		June 4	
Oklahoma—	**Light**	**Heavy**	**Light**	**Heavy**
Tonkawa	21,620	.....	21,935	.....
Burbank	45,645	.....	45,490	.....
Other Osage Fields	32,330	.....	32,915	.....
Cushing and Shamrock	21,410	.....	21,405	.....
Bristow and Eastern Bristow	26,740	.....	27,135	.....
Cromwell	12,950	.....	12,640	.....
Garber	14,220	.....	14,260	.....
Blackwell-Braman	12,205	.....	11,915	.....
Seminole	362,280	.....	360,355	.....
Wewoka	18,700	.....	19,030	.....
Northern Miscellaneous	114,180	.....	115 710	.....
Southern Fields	68,060	.....	68,765	.....
Total Oklahoma	750,340	.....	751,555	.....
North Louisiana	39.755	8,610	39,445	8,050
Arkansas	24,230	87,520	24,370	88,620
North Central Texas	164,435	.....	167,150	.....
West Texas	112,000	.....	115,723	.....
Texas Panhandle	126,920	.....	134,640	.....
East Central Texas	34,355	.....	35 220	.....
Kansas	112,560	.....	113,880	.....
Total Mid-Continent Area	1,364,604	96,130	1,381,981	96,670
Gulf Coast	.....	153,490	.....	154,585
Southwest Texas	.....	34,850	.....	35,065
Eastern	113,500	.....	113,000	.....
Rocky Mountain Area	84,990	.....	90,510	.....
California—				
Santa Fe Springs	42,000	.....	42,000	.....
Long Beach	95,000	.....	93,000	.....
Torrance	6,000	17,500	6,000	17,500
Huntington Beach	75,000	.....	75,500	.....
Dominguez	16,000	.....	16,500	.....
Rosecrans	10,500	.....	10 000	.....
Inglewood	24,000	12,000	24,000	12,000
Ventura Avenue	36,000	.....	38,500	.....
Seal Beach	65,000	.....	54,000	.....
Remainder of State	57,000	189,000	57,000	188,000
Total California	426,500	218,500	416,500	217,500
Total United States	1,989,594	502,970	2,001,993	503,820
Grand Total		2,492,564		2,505,813

Total Decrease, 13,249 Bbls.; Light Oil Decrease, 12,399 Bbls.



Little Activity in Oklahoma Market

Demand Dull for Practically All Products. Natural Gasoline and Kerosene Again Lowered. Refinery Gasoline Unchanged

By C. O. Willson

A general inactivity which was reflected by a price weakness in several products summarized the Oklahoma (Group 3) refined market the first of this week. Prophecies made that June would witness an improvement in the demand for the output of Oklahoma refineries, especially gasolines, have to date failed to materialize with predictions now heard that there will be no improvement over the remainder of the month.

Up to Tuesday, Oklahoma refiners generally were holding to the gasoline prices established the previous week which in turn were slightly higher than the price levels in effect the last week in May. It was admitted by the sellers that new business was not being placed in the volume expected and it was feared that a few refiners at least might find it expedient to offer price concessions to secure orders before the end of the week. Buyers, including jobbers and marketers, reported offers of exceptionally large quantities of gasoline from refiners either for immediate shipment or for delivery over the remainder of the month. These offers showed that many refiners, including several of the larger operators, were willing to sell at present prices over the next 15 days at least.

Natural Gasolines Lower

One factor in the refinery gasoline situation is the continued slump in natural gasoline prices. The A and B grades dropped an additional one-quarter to one-half cent in price during the past week and the lower prices have not increased with the demand. With their own movement disappointing, Mid-Continent refiners are slow in making natural gasoline purchases. Outside the Mid-Continent the large refiners in the Gulf Coast area continue out of the market. The only exception was a 600-car purchase by the Humble Oil & Refining Co. This entire order is understood to have been placed with one Mid-Continent manufacturer. This company has a large quantity of natural gasoline in storage.

Inquiries from other coastal buyers indicate that refiners there are keeping in touch with the Mid-Continent natural gasoline market. Apparently these buyers are waiting for bottom prices before placing their orders. This coastal buying in May resulted in an advance in prices which placed natural gasolines near a price parity with U. S. Motor gasoline.

Gasoline Stocks

Many of the trade, including buyers as well as sellers, have been surprised at the weakness apparent in all gasolines. The statement is constantly made that Mid-Continent refiners are in a strong position in regard to gasoline stocks with their current operations on a healthy basis. It has been assumed that this situation would bring about prices in June which would permit generally profitable operation, a situation which did not obtain during April and May.

In this connection attention is called to the accompanying table which shows where the gasoline stocks were located on May 1 with comparison made of stocks on the same date of the previous year. This table bears out the statement that gasoline stocks in the Mid-Continent are not large. This is a statement, however, which can be made at any time since stocks in that area and other interior points are always relatively low when compared to the stocks in the hands of coastal refiners.

Distribution of Gasoline Stocks
(Thousands of barrels.)

	May 1, 1927	May 1, 1926	Incr.
East Coast	11,166	9,572	1,594
Appalachian	1,246	1,057	189
Indiana, Illinois, etc.	5,690	6,467	*777
Oklahoma, Kans., etc.	4,595	3,933	662
Texas	7,331	5,434	1,897
Louisiana-Arkansas	3,649	4,023	*374

(Continued on Page 364)

REFINED MARKET BAROMETER

No price changes of a general nature developed in refined markets throughout the United States during the past week. Gasoline prices generally were firm, although sellers were uneasy in some areas relative to possible developments over the remainder of the month. Lower tanker rates, coupled with large excess material in the hands of California refiners is being reflected in an increased movement of gasoline from the West to the East Coast, a development not considered favorable for the eastern domestic market. Although the domestic gasoline market on the West Coast is unchanged, sales for export and East Coast movement are being made at low prices to reduce excess stocks. Price changes in kerosene reflected a lessened demand, partially offset by a more active distillate demand. Natural gasoline prices continued to slump in the eastern areas and on the West Coast the small movement outside of contract sales also reflects a weakness. Fuel oil and gas oil prices are unchanged, with the coastal market especially active since the recent reduction in prices. Prices on cylinder stocks, bright stocks and neutral oils were practically the same as last week. Wax prices were unchanged.

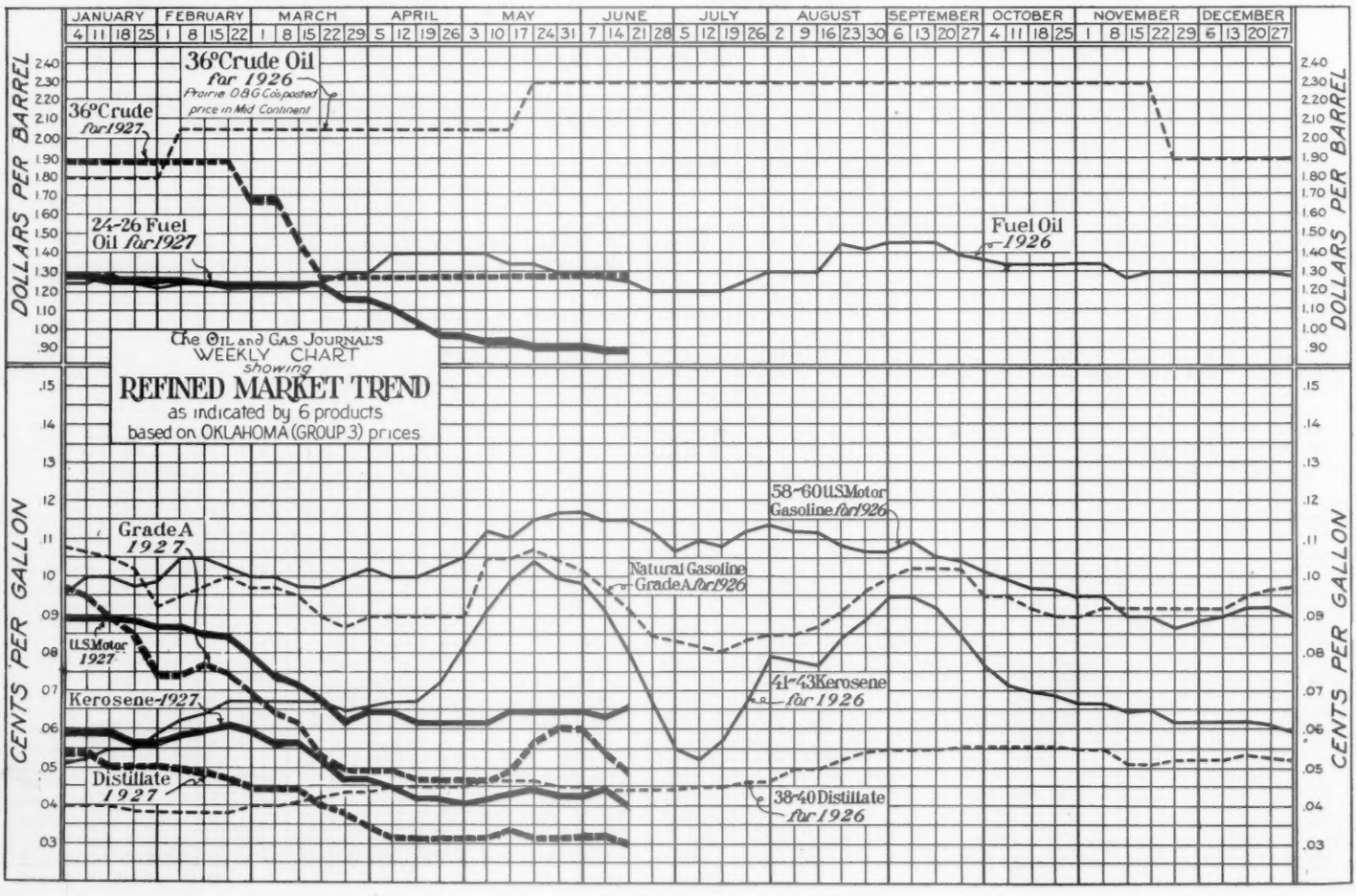
Mid-Continent—Natural gasoline prices lower. Refinery gasoline prices steady. Kerosenes weaker in North Texas and Oklahoma. No general changes in fuel oil and gas oil prices. Lubricants and wax firm.

Atlantic Seaboard—Believe gasoline prices at bottom. Greater receipts of California gasoline. Kerosene unchanged. Fair demand for fuel oil and gas oil with prices unchanged. Lubricants firm. No improvement in wax demand.

Pennsylvania—Very few price changes. Some grades of higher gravity kerosenes reduced.

California—No change in domestic gasoline market. Natural gasolines weak. Other products unchanged.

Chicago—Gasolines inactive with lower natural gasoline prices. Kerosenes weaker. Gas oil strong. No change in fuel oils.



Crude Small Factor in Gasoline Cost

Represents Less Than One-Fourth Price at Filling Station. Taxes and Other Costs Do Not Fluctuate

By L. M. Fanning
New York Bureau, The Oil and Gas Journal, Room 629, No. 101 Park Avenue, New York, N. Y.

It can be fairly said that the co-operative era in the industry has been launched, for from all points and in every port of the business strong sentiment toward this end is being expressed and actual headway is being made. The attitude of the Federal Oil Conservation Board favoring co-operation in the industry and co-operation with the Government makes the picture of the approaching epoch complete.

One of the requirements of effective co-operation in the petroleum industry is comprehension of simple fundamental facts. Probably the simplest but the least understood fact relating to the present situation—and which, in its relation to the industry's mutual understanding and the public's attitude, is of outstanding importance—is that retail gasoline prices generally throughout the country have declined comparably with the cuts in crude oil.

Opinion has been expressed, within and without the industry that relatively, gasoline prices are out of line with crude prices, and the basis for this is obviously a misapprehension as to the extent to which crude oil enters into the cost of getting motor fuel to the filling station pump. As a matter of fact, it is a proportionately small item.

The Government at Washington is closely watching the oil industry in its present situation. It goes without saying that a matter of principal concern to it is what the consumer is paying for his gasoline. With the overproduction and reduced crude oil price, so thoroughly advertised by the industry, Federal officials naturally look for a slicing of gasoline prices such as has occurred in crude oil.

The charges on a gallon of gasoline, such as taxes, transportation and other costs which cannot be reduced, constitute the major portion of the price. And, contrary to general opinion, the crude oil cost entering into the price of gasoline is relatively small.

To take the District of Columbia, where official Washington, watching the oil industry, gets its first hand information about gasoline prices, the motorist is buying his fuel at 17 cents a gallon. Incidentally, this is not representative of the price elsewhere in the East because at the present time local competition has resulted in a reduction as against prices prevailing elsewhere in the territory.

If crude oil were given away at the wells in the Mid-Continent Field, no one could retail gasoline at Washington for less than 14 cents a gallon and come out even on it.

The pity of it is that neither the producer nor consumer understands this fundamental fact.

While the gasoline price relationship is thus clouded, the same is not true as regards the crude oil cost situation. The Okmulgee District Oil and Gas Association in its recent commendable effort to find relief for the producers brought out that crude oil is being produced at below cost in many areas in its resolution submitted to the Oil Conservation Board. Everywhere in the industry this is known to be true. The association also reflected the views favorable to co-operation and offered constructive aid to bring about co-operative measures in the industry and with the Government.

At the same time, as indicating the general lack of comprehension of the price relation of gasoline to crude oil, the organization stated that no reduction had taken place in the price of refined products comparable to the cut in crude. This is true as regards percentages, but percentages have no accurate bearing. As a matter of fact, due consideration to the chain of factors entering into the price paid by the consumer for his finished products shows that the full extent of the reductions in crude has been experienced by the buyer of gasoline and other products.

Factors entering into gasoline price beginning with crude at the well and the filling of the motor cars tank, are as follows:

Cost of crude oil.
Transportation of crude ol.
Refining.
Freight on distribution.
Bulk station and tank wagon distribution.
State and inspection taxes.
Incidental costs and profit to refiner and distributor.

On June 1, 1926, the price of Mid-Continent crude at the wells was at its highest level for the year. The average gravity of pipe line oil was about 38 degrees, the posted price for which grade was $2.45 per barrel, or 5.83 per gallon.

On June 1, 1927, the price for this grade was $1.32 per barrel, or 3.14 cents per gallon. In the intervening year the price of this representative grade declined 46 per cent, that is, $1.13 a barrel, or 2.69 cents per gallon.

Of the many items that make up the cost of gasoline the only one which has declined is the cost of the raw material. If the retail price of gasoline has declined by as much as 2.69 cents the full amount of the decrease in costs has been passed on to the consumer.

Based on retail gasoline prices prevailing in 50 representative cities, the average sales price to the motorist a year ago was 22.03 cents. On June 1 of this year it was 18.10 cents, a decline of 3.93 cents.

That means that the other branches of the industry not only accepted the cut in crude, but added another 1.24 cents per gallon to that saving. Actually, the refiners and distributors did better than that, for they absorbed in addition an increase of 0.27 cents a gallon in road taxes that were increased during the year.

It appears that the contrary impression held by part of the producing industry and generally by the public is due to overemphasis of the influence exerted by the price of crude upon the retail price of gasoline.

Actually, crude oil price represents less than 25 per cent of the price of gasoline at the pump.

Gathering and pipe line charges, water and rail freight, retail delivery, road and inspection taxes—all these are fixed charges that do not change with the fluctuations in crude.

Road taxes and inspection fees on gasoline alone, averaged the country over, are as much per gallon as the producer receives for a like amount of crude.

It is not easy to compile retail figures for kerosene, gas oil and fuel oil, which together with the major product, represent about 90 per cent of the total consumption. Taking the wholesale prices for the four products it is found that since June 1, 1926, the percentage decline in the Mid-Continent area is 44 per cent or almost exactly the percentage decline in the cost of crude.

It is apparent, then, that the full amount of the very substantial decline in the price of crude has been carried through to the benefit of the consumer, despite the fact that the reductions at the pump appear relatively small when set off against the retail price of gasoline.

As pointed out in a recent editorial in The Oil and Gas Journal a definite start at co-operation has been made in the producing end of the business. What is being done and attempted in that branch of the industry is but a forerunner of general co-operation in all branches—producing, refining and marketing.

The first step towards this co-operation is a more general understanding of causes and their relation to present problems.

Thus, fundamental facts to be understood by the industry may be listed as follows:

That the cost of crude oil is a relatively small part of the cost of gasoline to the motorist.

That present gasoline prices reflect the declines in the price of crude oil at the well,

That the major portion of the charges on a gallon of gasoline is made of costs that do not fluctuate with the price of crude.

It is hoped that this presentation of facts in The Oil and Gas Journal will clarify the situation and be another contribution toward the effective cooperation of the industry.

GASOLINE PRICES REFLECT CUT IN CRUDE

Probably the simplest but the least understood fact relating to the present situation is that retail gasoline prices generally thorughout the country have declined comparably with the cuts in crude oil.

Contrary to general opinion, the crude oil cost entering into the price of gasoline is relatively small.

To take the District of Columbia, where offiicial Washington, watching the oil industry, gets its first hand information about gasoline prices, the motorist is buying his fuel at 17 cents a gallon. Incidentally, this is not representative of the price elsewhere in the East because at the present time local competition has resulted in a reduction as against prices prevailing elsewhere in the territory.

If crude oil were given away at the wells in the Mid-Continent Field, no one could retail gasoline at Washington for less than 14 cents a gallon and come out even.

The pity of it is that neither the producer nor consumer understands this fundamental fact.

As pointed out in a recent editorial in The OIL AND GAS JOURNAL a definite start at co-operation has been made by the producing end of the business. What is being done and attempted in that branch of the industry is but a forerunner of general co-operation in all branches—producing, refining and marketing.

The first step towards this co-operation is a more general understanding of causes and their relation to present problems.

Half-Year Production Estimate

The production for the first six months in 1927 will by far exceed that of any other six months in the history of the oil business. It is estimated that it will be around 444,750,000 barrels. In order to better visualize what this quantity of petroleum represents a comparison is made between the first six months of this year and the greatest six months production in 1923 when several great fields in California, the Powell Field in Texas and Burbank and Tonkawa in Oklahoma yielded so largely as to demoralize the whole petroleum structure. The biggest six months production in 1923 was from June to November, both inclusive, and the total crude output was 398,052,000 bbls., while the first six months of this year will exceed that figure by nearly 46,700,000 bbls. The period chosen for 1923 figures represented 183 days, while the first six months of this year include only 181 days. The average production for the first six months of this year will be approximately 2,457,000 bbls. while the biggest six months in the previous overproduction period represented a daily average of approximately 2,175,000 bbls., indicating an increase in the first half of this year of 282,000 bbls. per day.

In the heydey of the Smackover deep sand development in 1925 397,978,000 bbls. of oil was produced in the United States from May to October, both inclusive, a period of 184 days. This quantity fell a little short of the production during the most prolific six months in 1923.

Problems in Overproduction of Oil

President of American Petroleum Institute, at Standardization Conference at Colorado Springs, Urges World View

By E. W. Clark*
President of the American Petroleum Institute

It is indeed gratifying to be called upon to say something in the way of an opening address to you gentlemen who are gathered here today to carry on the serious business of standardizing oil country equipment.

When you started to work the tools, equipment and oil country goods were a wilderness of individual effort. As an institute we are proud of the fact that an integral part of our organization has been so successful in its efforts in the short time you have been working. The entire industry is grateful to you. The hardest thing that you had to do was to standardize or simplify your equipment. This was an easy matter in comparison with the change in the mental habits of the industry. It was, therefore, perfectly natural that in the beginning the principal manufacturers of equipment should have been opposed to anything you proposed to do. It is not to their discredit that this should have been their position. Each one of them knew that he was making good equipment and that it would work satisfactorily.

You had the good fortune to start right under sound leadership. Huge sums of money will be saved to the industry, the equipment manufacturer, distributor, and the oil consumer. I believe that they will be of such a substantial character that had the institute done nothing other than standardization work, the entire expense of institute organization in carrying on since its inception would be fully justified. But it must be understood that this statement does not in any manner minimize the satisfactory results had in other divisions of our activities.

Learning to Co-operate

The men of the oil industry are being schooled in co-operation. As we become educated to its advantages we will do more; and it will be worth all we pay. The institute plans many more co-operative activities which, in time, will cover every phase of petroleum activity susceptible of co-operative work. You men are furnishing some of the blackboard illustrations of what can be done and how.

The general object of all business is to get and furnish commodities to satisfy the public's requirements. American industry is trying to conduct its business under a regime of untrammelled competition, with as much freedom of action and noninterference from Government as possible, upon the accepted theory that only thus can industrialism reach its apex of efficiency. The oil industry is no exception. We assert that the law of supply and demand controls our industry and the units engaged in it. Price must rise as long as demand is in excess of supply, and must fall as long as supply is in excess of demand. Price must move up or down until some figure is reached which equates supply and demand.

"An economic order in which the regulative mechanism was efficiently operative for short periods only,—being every now and then completely thrown out of gear, so that a highly disordered state of things ensued,—would be considered by everyone seriously defective, if not unendurable. An economic order to be really satisfactory, ought to show steadiness, regularity, dependableness,—ought to be free from all marked perturbations. Now in this respect, our system unfortunately does not work so well as we might desire. It is a familiar fact that production is subject to marked, almost violent, fluctuations, which naturally group themselves into the so-called industrial cycle; depression, recovery, increasing activity, normal activity, overtrading, crisis, collapse, depression, and so around again."

The paragraph which I have just read you is not my own language. It was not written to describe the oil industry. It is quoted from the chapter on production efficiency of a modern textbook on "Principles of Economy." The oil business is experiencing one stage of the industrial cycle; the regulative mechanism of production is out of gear and a highly disorganized condition exists. We cannot escape the fact. As the economist aptly says: "Now in this respect, our system does not work so well as we might desire."

We operate under a competitive system; and while there are admitted economic wastes under such a system, there is no power to alter, over night, the fundamental law or the underlying principle. That there is such power is commonly and frequently overstated. Producers and refiners of oil may, at times, gain much by reducing or checking output. The most effective procedure obviously would be through concerted action of all producers or all refiners, because it is the limitation of total output which counts most. Concerted action of such character, however, contradicts the very essence of our present law and procedure; and if practiced for the avowed purpose of market stability, it results only in prosecution and public condemnation,—two things from which all men shrink.

Industry's Methods

The present system of oil production was not designed deliberately by anyone. It is not some prearranged co-operative thing. It is but an automatic development of the conditions as they become known, surrounding production, plus the spontaneous and perfectly normal outgrowth of the private commercial enterprise which oil men ever have demanded as their right and need. We soon find out when we are overstocking and oversupplying the oil markets of the world, and we know that competition for gallonage should instantly cease where economic advantage leaves off and financial sacrifice begins. Yet we go merrily along, doing over and over again things we know in advance will surely produce oversupply.

What do we learn when we drill an oil pool in a hurry? Is it that the more wells we drill at the same time the more oil we get at the least cost? Hardly. On the contrary have we not learned:—

First. That the more wells we drill at the same time the greater the per-barrel increase in the cost of the total oil recovered from the pool.

Second. That the more wells we drill at the same time, the more gas pressure is immediately released, thereby diminishing the total ultimate oil recovery, because maintenance of gas pressure increases the rate of yield and the total amount obtainable.

Danger of Overproducing

Third. That the more wells we drill at the same time, the greater the likelihood of bringing to the surface a quantity of oil which will be forced on an oversupplied market at such a low price as "leads to wastefulness and disregard of essential values."

Knowing all this, why do we do these things? We time and time again exhibit a Ph. D. degree to prove our intellectual capacity to co-operate in work we ought not to do. Why can we not get a correspondence course degree for co-operation in things where we ought to work together?

When a man installs a plant to heat his house he has it designed to meet the peak cold weather load. Does he change his plant to fit every condition of weather? Of course not. He regulates the quantity of fuel he feeds it. He does not unendurably overheat his house in summer by piling on fuel. That would be ridiculous.

In the oil business, we have a system of production which has grown out of our experience. It is our heating plant. The industry wants to follow correct principles of economics and the physical laws which control operation. Every time we stokers go out and stoke the furnace with fuel when weather conditions do not require it, we have violated both an economic and a physical law. We unendurably overheat things, and money pours out the pores of the industry's skin in rivulets of gold.

Production has run around the industrial cycle because the last lesson did not stick and we operators failed to check or limit our individual activities until so late none of us seems wise enough or powerful enough to stem the flood. So, knowing nothing else to do, we cuss the business, its so-called leaders, and the Government. Since we cannot change our system overnight to meet the situation, there is nothing left to try to run the system a little easier and a little slower, while we are cooling off from the work of the over-zealous stokers.

Counsels of Caution

For what they may be worth in the discussion now going on, I have a few general observations to make.

First. Let us seek the real meaning of an industry co-operating; get the real spirit of it, and then practice it.

Second. Get a copy of "The A B C's of Science in Oil Recovery," which the institute has obtained from an eminent physicist and published in pamphlet form; sit down, read it, and do some hard thinking.

Third. Believe me when I tell you that the Federal Oil Conservation Board, appointed by President Coolidge, has a sincere and earnest desire to help this industry solve its most serious problem. In my judgment, the industry will make an egregious error if it does not embrace the opportunity to work out for itself, with the intelligent co-operation of this agency of Government, a permanent national policy with respect to oil production.

As we shall demonstrate ability to co-operate among ourselves, we shall gain in the confidence of the public and of government agencies. Personally, I have no doubt whatever of the genuine wish of government authorities to help our industry, or any other industry that is found in the position we occupy today. I believe all the tendency of the times is toward intimate and genuine understanding and relationship between business and Government, to promote the interest of both which means the welfare of the public.

Inheritance of Laws

A good many of us think we know procedures and co-operations that would ameliorate present difficulties. The trouble with applying them is that we assert we have laws which stand in the way. If so, they have been left over to our time from a period when the popular conception assumed that Government and business must almost necessarily be antagonistic. But we have passed on to the time when the ideal of co-ordination, of co-operation, of understanding, of confidence rather than suspicion, is constantly held up before us. The creation of the Federal Conservation Board was an invitation to us. The industry accepted that invitation, and because it did so in all good faith, we have had many testimonies of Government's desire to go along with us, to help us work out our

(Continued on Page 321)

* Before Third Semi-Annual A. P. I. Standardization Conference, Colorado Springs, Colo., June 15.

WIDER DISTRIBUTION IS KEYNOTE OF STANDARDIZATION CONFERENCE

By Andrew M. Rowley

COLORADO SPRINGS, Colo., June 14.—Practical utilization of the results achieved after years of intensive study and work by members of the different committees on standardization of the American Petroleum Institute is the key note of the third semiannual standardization conference which will open formally here tomorrow morning with an address by E. W. Clark, president of the institute. The conference actually got well under way today as members of committees and leaders in the petroleum equipment and supply business are already here and holding meetings while several of the committees held scheduled meetings today to consider reports and certain matters in advance of the formal opening of the conference.

When it is considered that more than 500 executives, engineers and field men have given freely of their time and labor to the work of standardization during the past five or six years and that the time has arrived when specifications are practically completed on all or most of the items listed on the standardization program, the importance of the present conference may easily be visualized. The big problem now is to obtain widespread use of the standards adopted, hence this conference is of especial interest not only to oil company executives but to purchasers and manufacturers of oil field equipment.

Manufacturers in different sections of the country already have expended large sums of money in changing patterns, equipment, etc., to be able to market equipment under A. P. I. specifications and intensive efforts will be made from this time to obtain the co-operation of buyers of oil field drilling and producing supplies to specify equipment bearing the A. P. I. standardization mark.

While Pike's Peak, the Garden of the Gods and other points of scenic beauty may beckon the men attending the standardization conference, there is little chance for anyone to go sightseeing until after next Saturday for the various committees have meetings scheduled every morning, afternoon and night during the next three days, with general sessions interspersed so that there is very little time available for anything but hard work until next Saturday. Even Saturday may be a day of hard work for some for the big golf tournament is scheduled for that day.

The golfers among these engineers, oil company executives and supply and equipment men may be enthusiastic about the game but they are almost as pessimistic as were the oil producers before definite steps were inaugurated recently to minimize the menace of future overproduction. I remarked to one man I had a good idea for winning the golf driving contest. I suggested that I go

(Continued on Page 361)

Efficacious Use of Core Drilling

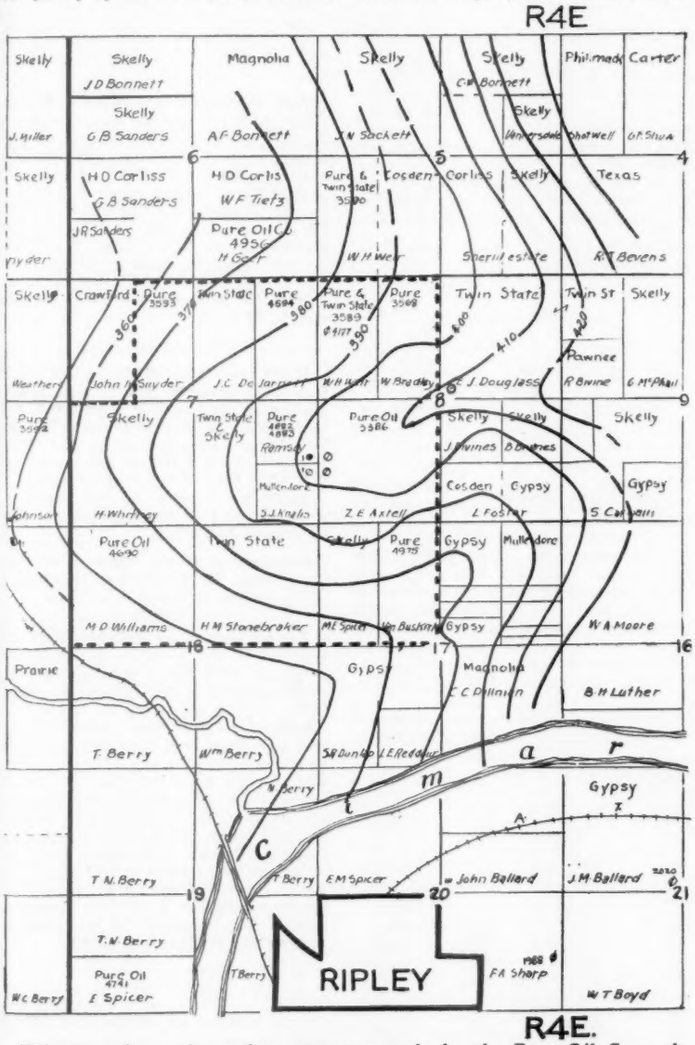
After Surface-Structure Geology Failed, the Core Drill Made Good in a Joint Operation in Oklahoma

By J. L. Dwyer

The Wilcox sand well drilled recently in Section 7-18-4, Payne County, Oklahoma, emphasizes the importance of the core drill, and the co-operative system of drilling and operating oil properties, and really marks a new epoch in the industrial history of oil.

While numerous properties of small yield have been drilled and produced by co-operative management, this might really be termed the first good trial which this sort of oil operation has had, for the well is making close to 4,000 bbls. daily.

Under the plan formulated and worked out jointly by the Pure Oil Co. and the Twin State Oil Co. the entire block of acreage was included in one lease, and the Skelly Oil Co. having several leases on the structure, was invited to participate in the operation and consented.



This map shows the surface structure made by the Pure Oil Co. and Twin State Oil Co. geological departments, based upon the Neva Lime.

Division of Interest

All acreage held by the three companies was pooled, and assignments were exchanged between all the companies involved, each giving the other two assignments for proportionate share of the acreage. When the details of the plan had been completed, the Pure Oil Co., which held the largest amount of acreage, was in possession of an 18-33 interest of the entire block, or about 54 per cent. The Twin State Oil Co. was in possession of an 8-33 interest, or about 24 per cent, and the Skelly Oil Co. was in possession of a 7-33 interest, or 21 per cent. Working upon this plan, the expenses of drilling the well were apportioned among the three concerns, and the operation of the property was handled similarly to the management of a corporation, each of the three companies having one representative whose task corresponded to the director of a corporation.

The result of this plan can be best demonstrated when it is considered that although the well has opened up a new Wilcox Sand pool, and is making a good production daily, only three additional wells have been started upon the block, and had the leases been owned individually, it is estimated that at least 18 or 20 wells would have been started by this time.

Work of the Core Drill

A very interesting comparison between the efficacy of surface geological work and the work of the core drill is also found in a study of the maps showing structures worked by surface surveys, and by the use of the core drill. The two maps accompanying this story offer ample opportunity to compare both these surveys, and the contour lines shown would hardly be recognized as the same structure.

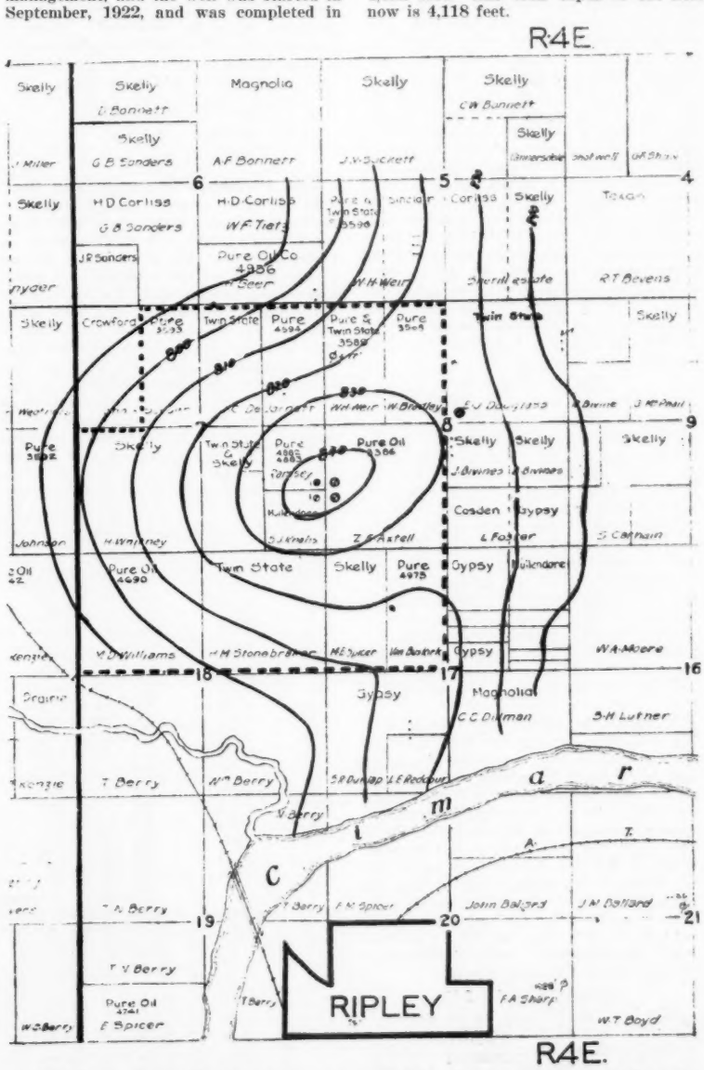
The surface work shows a nosing, while the core drill map reveals a closure and some east dip. Both the work of the core drill and the surface survey were based upon the Neva Limestone which crops out along the banks of the Cimarron River. As a further check upon the work of the core drill, it was used to drill down to the Cushing Limestone, which is found approximately 100 feet below the Neva in that territory. The results showed the dependability of this type equipment in surface work.

The prospecting work was done by the Pure Oil Co. and the Twin State Oil Co. jointly during the early part of 1922. As a result of their finding some evidences of a structure, they pooled their interests and drilled the dry hole shown on the map in the SW cor NW NW Section 8-18-4.

Both companies were fortified with lease holdings, and by agreeing upon a joint well, they were spared the expense of drilling an extra well to test out the possibilities of two sets of leases. It was one of the first instances of joint management, and the well was started in September, 1922, and was completed in July, 1923. The Wilcox Sand was found to be barren, and the hole was plugged back to the Bartlesville Sand found at 3,682 feet. The well pumped 7 bbls. daily from this sand for several months, after which it was plugged and abandoned. The well had a small showing in the Wilcox Sand, and this encouraged the owners to continue their geological work in the area.

With the introduction of the core drill in Oklahoma oil field practice, the Pure Oil Co. and the Twin State Oil Co. shared jointly the expense of using this equipment to obtain additional information about the region. After the entire area was sufficiently core drilled, and the formations named above (Neva and Cushing Lime) located, it was apparent that the original geological work failed to disclose the true condition upon the east side of the structure. The core drill plainly showed the closure and the east dip.

The second well found the Wilcox Sand at 4,038 feet, with the first gas at 4,058 feet. Some lime was then found and sand again at 4,070 feet. The second gas was found at 4,010 feet and the oil at 4,011 feet. The total depth of the hole now is 4,118 feet.



This map shows the structure as revealed by the core drill work done by the Pure Oil Co. and Twin State Oil Co. geological departments. It is based upon the Neva Lime and also the Cushing Lime.

Principles of the Air and Gas Lift

All Phases of This Important Subject Explained and Data and Formulas Furnished by Recognized Expert

By S. F. Shaw
Consulting Engineer

Recent operations in the production of oil by means of gas and air lifts in Seminole, California, the Panhandle, and various other places have attracted considerable attention, and it appears to be the belief of many people that the gas lift is a recent invention. Such, however, is far from being the case since the use of the air lift is said to have been discovered by C. E. Loscher in 1797. A patent was obtained on the air lift in the United States more than 40 years ago by Dr. J. G. Pohle, who appears to have made the first successful use of this method of lifting liquids. Air lifts were employed at Evangeline, La., and at Humble, Tex., with a considerable degree of success many years ago, and subsequently this method of lifting oil has been employed at Goose Creek, Hull, Orange, Spindletop and other fields on the Gulf Coast.

Air lifts were employed at Baku, Russia, in 1899, and increased the production greatly over the crude methods previously in use. Gas lifts were being started on a small scale during the first part of 1925 in oil fields in the Los Angeles Basin, and were attended with a fair degree of success even though the methods employed were not very efficient. Late in 1925, gas lifts were installed in Tonkawa, which was the first use of this method of much importance in the Mid-Continent. During the summer of 1926 the writer changed the designs of several gas lifts already installed at Tonkawa, Braman, and Garber to more efficient designs and rather remarkable results were obtained over methods previously in use. This work lent much encouragement to gas lift operations in the Mid-Continent, resulting in the starting of gas lift work at Seminole during the latter part of 1926. Recent production of over 150,000 bbls. per day by gas and air lifts in Seminole is holding attention at this time.

Air and Gas Lift

There is no essential difference between an air lift and a gas lift so far as the lifting effect is concerned. An air lift is a gas lift in which the particular gas being employed as a lifting medium is air. At the present time besides air, natural gas and residue gases, containing methane, ethane, and small admixtures of the heavier hydrocarbon gases, are employed for lifting oil. When air is employed in an oil well it is commonly termed an air lift, although the issuing gas is a mixture of air, methane, ethane, carbon dioxide, etc., since the production of oil is almost always accompanied by a certain amount of natural gas which issues with the oil and air.

It should be emphasized that a flowing well is a natural gas lift, in which the compressed gas is supplied by nature and is dissolved in, mixed with, or associated with, the oil in some form, and issues with the oil. It would be more accurate, perhaps, to say that the oil issues with the gas, since it is the movement of the gas through the sands and up through the casing that carries the oil with it. With the exception of wells caused to flow by hydrostatic pressure behind the oil, there would be no natural flowing of oil in wells if there were no gas associated with the oil.

Principles of Air Lift

The laws of thermodynamics governing the principles of the air lift are as invariable and as dependable as the laws governing the generation and transmission of steam and electricity. A perfect gas when compressed or expanded isothermally follows Boyle's law which is expressed by the general formula:

$$PV=P_1V_1=P_2V_2=P_nV_n \quad (1)$$

That is, the product of pressure and volume of a given quantity of gas is constant.

A unit volume of gas will be raised in pressure but diminished in volume if compressed from a lower to a higher pressure. In making computations, absolute pressures must be employed. Thus, if one cubic foot of gas at atmospheric pressure be raised to 100 pounds gauge pressure, the volume would be as follows:

$$V_1\times(100+14.7)=V\times14.7$$

or

$$V_1=\frac{V\times14.7}{(100+14.7)}=\frac{1\times14.7}{100+14.7}=0.128$$

Work Performed in Compressing Gas

In order to raise a unit volume of a perfect gas from a lower to a higher pressure, a certain quantity of work must be performed; conversely, if a unit volume of gas expands from a higher to a lower pressure, a certain quantity of work is performed, or given out. If the compression of gas is performed isothermally, that is, if no change of temperature takes place during the operation, this quantity of work for the same conditions is constant. When gas is compressed in a compressor, an additional quantity of work is required to overcome losses due to heat and friction, but in air lift operations we are not concerned with the losses taking place in compressing the gas. The flow of gas in an air lift is accompanied by so large a mass of liquid that the expansion is practically isothermal and losses that would otherwise result from expansion are practically negligible.

The work performed during the expansion of a perfect gas from a higher to a lower pressure is given by the formula:

$$W=PdV \quad (2)$$

and when expanding from volume V_1 to V_2 would be:

$$W=\int_{V_1}^{V_2} PdV$$

$$\text{Since } P_1V_1=P_2V_2=PV$$

$$P=\frac{P_2V_2}{V}$$

$$\text{Then. } W=P_2V_2\int_{V_1}^{V_2}\frac{dV}{V}=P_2V_2\times\log_e\frac{V_2}{V_1}=$$

$$P_2V_2\times\log_e\frac{P_1}{P_2} \quad (3)$$

Where:
P_2=the higher pressure
V_1=the volume corresponding to P_1
P_2=the lower pressure
V_2=the volume corresponding to P_2

If we assume the volume V_2 to be the unit volume and take this as 1 cubic foot; and assume the lower pressure to be atmospheric pressure, or 14.7 pounds per square inch, and if we employ absolute pressure in pounds per square inch, the formula becomes:

$$W=144\times14.7\times1\times\log_e\frac{P_1}{14.7} \quad (4)$$

Table No. 1 gives the foot pounds of work performed by the isothermal expansion of a perfect gas from a given gauge pressure to atmospheric pressure of 14.7 pounds per square inch. Table No. 2 gives the foot pounds of work performed by gas expanding isothermally from atmospheric pressure of 14.7 pounds to an absolute pressure lower than atmospheric pressure.

TABLE NO. 1
Foot Pounds of Work Required to Compress One Cubic Foot of Gas Isothermally to a Given Pressure

Lbs. per Sq. In.	Foot Lbs. of Work	Lbs. per Sq. In.	Foot Lbs. of Work	Lbs. per Sq. In.	Foot Lbs. of Work	Lbs. per Sq. In.	Foot Lbs of Work
10	1,107	260	6,199	510	7,568	760	8,392
20	1,819	270	6,274	520	7,608	770	8,420
30	2,354	280	6,347	530	7,647	780	8,446
40	2,782	290	6,417	540	7,685	790	8,473
50	3,137	300	6,486	550	7,723	800	8,499
60	3,441	310	6,552	560	7,760	810	8,525
70	3,707	320	6,616	570	7,798	820	8,550
80	3,943	330	6,678	580	7,833	830	8,576
90	4,156	340	6,739	590	7,868	840	8,601
100	4,349	350	6,798	600	7,902	850	8,625
110	4,526	360	6,855	610	7,937	860	8,649
120	4,689	370	6,911	620	7,971	870	8,674
130	4,841	380	6,965	630	8,003	880	8,697
140	4,982	390	7,018	640	8,036	890	8,721
150	5,115	400	7,069	650	8,068	900	8,744
160	5,240	410	7,120	660	8,100	910	8,767
170	5,358	420	7,169	670	8,131	920	8,790
180	5,469	430	7,218	680	8,162	930	8,812
190	5,575	440	7,264	690	8,192	940	8,835
200	5,676	450	7,311	700	8,222	950	8,857
210	5,772	460	7,356	710	8,251	960	8,879
220	5,865	470	7,400	720	8,280	970	8,900
230	5,953	480	7,443	730	8,309	980	8,922
240	6,038	490	7,485	740	8,337	990	8,943
250	6,119	500	7,527	750	8,365	1,000	8,964

TABLE NO. 2
Foot Pounds of Work Given Out When 1 Cubic Foot of Gas Expands From Atmospheric Pressure to a Given Absolute Pressure Below Atmospheric Pressure

Lbs. Pres. Absolute	Ft. Lbs of work	Lbs. Pres. Absolute	Ft. Lbs of work
14	103	5	2,283
13	260	4	2,755
12	430	3	3,364
11	614	2	4,223
10	816	1	5,689
9	1,039	0.1	10,562
8	1,288	0.01	15,086
7	1,571	0.001	20,312
6	1,897	.....	.....

TABLE NO. 3
Foot Pounds of Work Required to Lift One Gallon of Water to a Given Height

Ft.	Ft.Lbs.	Ft.	Ft.Lbs.	Ft.	Ft.Lbs.	Ft.	Ft.Lbs.	Ft.	Ft.Lbs.	Ft.	Ft.Lbs.	Ft.	Ft.Lbs.
1	8.35	16	133.6	31	258.85	46	384.1	61	509.35	76	634.6	91	759.85
2	16.7	17	141.95	32	267.2	47	392.45	62	514.7	77	642.95	92	768.2
3	25.05	18	150.3	33	275.55	48	400.8	63	526.05	78	651.3	93	776.55
4	33.40	19	158.65	34	283.9	49	409.15	64	534.4	79	659.65	94	784.9
5	41.75	20	167.0	35	292.25	50	417.5	65	542.75	80	668.0	95	793.25
6	50.10	21	175.35	36	300.6	51	425.85	66	551.1	81	676.35	96	801.6
7	58.45	22	183.7	37	308.95	52	434.2	67	559.45	82	684.7	97	809.95
8	66.80	23	192.05	38	317.3	53	442.55	68	567.8	83	693.05	98	818.3
9	75.15	24	200.4	39	325.65	54	450.9	69	576.15	84	701.4	99	826.65
10	83.5	25	208.75	40	334.	55	459.25	70	584.5	85	709.75	100	835.
11	91.85	26	217.1	41	342.35	56	467.6	71	592.85	86	718.1	...	.....
12	100.2	27	225.45	42	350.7	57	475.95	72	601.2	87	726.45	...	.....
13	108.55	28	233.8	43	359.05	58	484.3	73	609.55	88	734.8	...	.....
14	116.9	29	242.15	44	367.4	59	492.65	74	617.9	89	743.15	...	.....
15	125.25	30	250.5	45	375.75	60	501.	75	626.25	90	751.5	...	.....

A Pioneer in Gas Lift Methods

Mr. Shaw is generally regarded as the pioneer in the modern practice of the use of gas and air in the lifting of oil. He has been connected with the operations of the Carter Oil Co. in the Seminole Field in Oklahoma since last November and is given credit for much of the success of that company in its great production of oil in that field. For 20 years Mr. Shaw was connected with the Guggenheim interests, his work dealing largely with dewatering copper mines by use of the air lift.

Work Performed in Lifting a Liquid

The lifting of a given quantity of any liquid a given distance requires a fixed amount of work. Taking water as an example, 1 gallon of water weighing 8.35 pounds lifted 1 foot requires 8.35 foot pounds of work; 1 gallon of water lifted 100 feet requires 835 pounds of work. Expressing this in the form of a formula, the work performed in lifting 1 gallon of water to a given height L, requires the following number of foot pounds of work:

$$W_1=8.35\times L. \quad (5)$$

If we are lifting oil, instead of water, and if, for example, the oil has a specific gravity of 0.8, to lift 1 gallon 1 foot there will be required 0.8×8.35 foot pounds, or 6.68 foot pounds, and to lift 1 gallon of oil 100 feet will require 0.8×8.35×100, or 668 foot pounds.

Table No. 3 gives the foot pounds of work required to lift 1 gallon of water to various heights.

Determination of the Quantity of Compressed Air Required to Raise 1 Gallon of Water to a Given Height

Let us assume, for example, that it is required to lift 1 gallon of water to a height of 2,000 feet with compressed gas under pressure of 500 pounds per square inch, discharging same at atmospheric pressure; we will also assume that in this case there is no loss due to friction or other causes in the eductor column. In Table No. 4 we find that the work required to be done in lifting 1 gallon of water 2,000 feet is 16,700 foot pounds; in Table No. 1, which is worked out from formula (4), we find that 1 cubic foot of gas under pressure of 500 pounds per square inch discharging at atmospheric pressure contains 7,527 foot pounds of work. The quantity of gas required under these conditions is then:

$$\frac{16,700}{7527}=2.22 \text{ cu. ft.}$$

This assumes an efficiency of 100 per cent.

The quantity of gas required to lift 1 gallon of water to a given height can be expressed by the following formula:

$$Q=\frac{8.35\times L}{144\times14.7\times1\times\log_e\frac{P_1}{14.7}} \quad (6)$$

which can be simplified to the following:

$$Q=\frac{L}{254\times\log_e\frac{P_1}{14.7}} \quad (7)$$

Table No. 4, worked out on basis of the above formula (7) gives the number cubic feet of air at sea level basis required to raise 1 gallon of water a

given distance at 100 per cent efficiency when under a given pressure.

Gas-Oil Ratio

The gas-oil ratio, or number of cubic feet of gas that accompanies 1 bbl. of oil from the sand, is only the roughest kind of an indicator so far as lifting efficiency is concerned, since it does not take into account the height to which the oil is to be raised, nor the foot pounds of work stored in 1 cubic foot of the gas. For example, a gas-oil ratio of 100 cubic feet per barrel of oil may theoretically apply to a lift of 1,200 feet with gas at 100 pounds pressure, or to a lift of 2,500 feet with gas at 850 pounds pressure. Again, for a lift of 1,200 feet and 100 pounds pressure, 1 bbl. would be raised at efficiency of 100 per cent where the gas-oil ratio is 100; while for 1,200 feet lift at 850 pounds pressure, a gas-oil ratio of 49 cubic feet per barrel would be required at 100 per cent efficiency.

Efficiencies in Lifting a Liquid by Compressed Gas

The quantity of gas at 100 per cent efficiency given in the table in Table No. 4 is, of course, not the quantity of gas actually consumed in lifting 1 gallon of water to a given height. The actual quantity is ascertained by applying the efficiency factor to the theoretical figure. Thus, if 2.22 cubic feet at 100 per cent

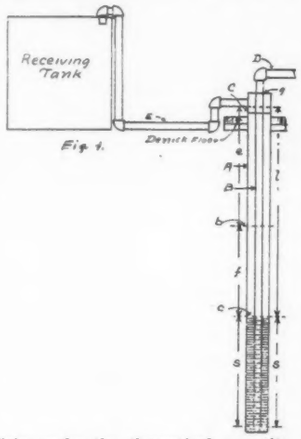


Fig. 1.

efficiency be the theoretical quantity to lift 1 gallon of water 2,000 feet with gas pressure of 500 pounds per square inch and if the design of the gas lift be such that an efficiency of 50 per cent is obtained, the actual quantity of gas required is then 2.22-0.50, or 4.44 cubic feet of gas per gallon of water.

The efficiency figure depends on the design of the air-lift installation and on the manner in which it is operated. Losses in efficiency in an air lift occur as follows:

1. Entrance losses at lower end, or footpiece.
2. Slippage losses, principally in the lower section of the flow pipe, or eductor.
3. Friction losses, principally in the upper section of the flow pipe.
4. Discharge losses, at the upper end of the flow pipe, or eductor.

The designs of the foot piece, of the flow pipe or eductor, and on the discharge arrangements or headpiece, control the losses at those points. These losses will be small or great depending on whether or not the designs are such as to meet the existing conditions in the most efficient manner.

A flowing well, that is, one in which the flow is not caused by hydrostatic pressure, is a natural gas lift, and air-lift principles should be observed as carefully as in an air lift where the gas is supplied by a compressor. Examples of natural gas lifts and of artificial air and gas lifts are given in Tables 5A and 6A.

Examples 12, 14 and 15 are those of wells equipped by the writer with air or gas lift.

In very few cases have wells flowing naturally been so equipped as to secure any but low efficiencies. Comparisons of efficiencies in the table No. 5A will illustrate this point. The work of installing equipment in a flowing well so as to secure acceptable efficiencies is somewhat difficult at times, but can be done especially if the proper provisions are made before the well is completed.

The table giving the quantity of air required at sea level, or 14.7 pounds per square inch, to lift 1 gallon of water, applies only to operations at sea level. When the discharge is at a lower pressure, such as would be the case at higher altitudes, a correction must be made for the quantity of air required to lift a gallon of water to a given height. Table No. 5 has been prepared to indicate the percentage of increase required.

TABLE NO. 4

Cubic Feet of Free Air, Sea-Level Basis, at Given Pressure, Theoretically Required to Raise 1 Gallon of Water to a Given Height in Feet

Feet Lift—	Lbs. Pressure at Bottom. 50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850
100	0.27	0.19	0.16	0.147	0.136	0.129	0.123	0.118	0.114	0.111	0.108	0.105	0.103	0.101	0.100	0.098	0.097
200	0.53	0.38	0.32	0.293	0.272	0.257	0.245	0.236	0.228	0.221	0.216	0.211	0.207	0.203	0.199	0.196	0.193
300	0.80	0.58	0.49	0.440	0.409	0.386	0.368	0.354	0.342	0.332	0.324	0.316	0.310	0.304	0.299	0.294	0.290
400	1.07	0.77	0.65	0.586	0.545	0.514	0.490	0.472	0.456	0.443	0.432	0.422	0.413	0.405	0.399	0.392	0.387
500	1.33	0.96	0.82	0.737	0.681	0.643	0.613	0.589	0.570	0.554	0.540	0.527	0.516	0.507	0.498	0.490	0.483
600	1.60	1.15	0.98	0.879	0.817	0.771	0.736	0.707	0.684	0.664	0.647	0.633	0.620	0.608	0.598	0.588	0.580
700	1.87	1.34	1.14	1.026	0.953	0.900	0.858	0.825	0.798	0.775	0.755	0.738	0.723	0.710	0.697	0.686	0.676
800	2.13	1.53	1.30	1.172	1.090	1.028	0.981	0.943	0.912	0.886	0.863	0.844	0.826	0.811	0.797	0.784	0.773
900	2.39	1.73	1.47	1.319	1.226	1.157	1.103	1.061	1.026	0.996	0.971	0.949	0.930	0.912	0.897	0.883	0.870
1,000	2.66	1.92	1.63	1.466	1.362	1.285	1.226	1.179	1.140	1.107	1.079	1.055	1.033	1.014	0.996	0.981	0.966
1,100	2.93	2.11	1.792	1.612	1.498	1.414	1.349	1.297	1.254	1.218	1.187	1.160	1.136	1.115	1.096	1.079	1.063
1,200	3.19	2.30	1.955	1.759	1.634	1.542	1.471	1.415	1.368	1.329	1.295	1.266	1.239	1.216	1.196	1.177	1.160
1,300	3.46	2.50	2.118	1.905	1.770	1.671	1.594	1.533	1.482	1.439	1.403	1.371	1.343	1.318	1.295	1.275	1.256
1,400	3.72	2.69	2.281	2.052	1.907	1.799	1.716	1.650	1.596	1.550	1.510	1.476	1.446	1.419	1.395	1.373	1.353
1,500	3.99	2.88	2.444	2.198	2.043	1.928	1.839	1.768	1.710	1.661	1.619	1.582	1.549	1.520	1.494	1.471	1.449
1,600	4.20	3.07	2.607	2.345	2.179	2.056	1.962	1.886	1.824	1.772	1.727	1.687	1.653	1.622	1.594	1.569	1.546
1,700	4.52	3.26	2.770	2.491	2.315	2.185	2.084	2.004	1.938	1.882	1.834	1.793	1.756	1.723	1.694	1.667	1.643
1,800	4.79	3.46	2.933	2.638	2.451	2.313	2.207	2.122	2.052	1.993	1.942	1.898	1.859	1.824	1.793	1.765	1.739
1,900	5.05	3.65	3.096	2.784	2.588	2.442	2.329	2.240	2.166	2.104	2.050	2.004	1.963	1.926	1.893	1.863	1.836
2,000	5.32	3.84	3.259	2.931	2.724	2.570	2.452	2.358	2.280	2.214	2.158	2.109	2.066	2.027	1.993	1.961	1.932
2,100	5.59	4.03	3.422	3.078	2.860	2.699	2.575	2.476	2.394	2.352	2.266	2.215	2.169	2.129	2.092	2.059	2.029
2,200	5.85	4.22	3.585	3.224	2.996	2.827	2.697	2.594	2.508	2.436	2.374	2.320	2.272	2.230	2.192	2.157	2.126
2,300	6.12	4.42	3.748	3.371	3.132	2.956	2.820	2.711	2.622	2.547	2.482	2.426	2.376	2.331	2.291	2.255	2.222
2,400	6.38	4.61	3.91	3.518	3.269	3.084	2.942	2.830	2.736	2.657	2.590	2.532	2.479	2.433	2.390	2.354	2.318
2,500	6.65	4.80	4.08	3.665	3.405	3.212	3.065	2.947	2.850	2.768	2.698	2.638	2.583	2.535	2.490	2.453	2.415
2,600	6.92	4.99	4.24	3.812	3.541	3.341	3.188	3.065	2.964	2.878	2.805	2.743	2.686	2.636	2.590	2.551	2.512
2,700	7.18	5.18	4.40	3.958	3.677	3.469	3.310	3.183	3.078	2.989	2.913	2.849	2.789	2.738	2.689	2.649	2.606
2,800	7.45	5.38	4.56	4.105	3.814	3.598	3.433	3.301	3.192	3.100	3.021	2.954	2.892	2.839	2.789	2.747	2.705
2,900	7.71	5.57	4.73	4.251	3.950	3.726	3.555	3.419	3.306	3.210	3.129	3.060	2.996	2.941	2.880	2.845	2.801
3,000	7.98	5.76	4.89	4.398	4.086	3.855	3.678	3.537	3.420	3.321	3.237	3.165	3.099	3.042	2.988	2.943	2.898
3,100	8.25	5.95	5.05	4.545	4.222	3.983	3.801	3.655	3.534	3.432	3.345	3.271	3.202	3.143	3.088	3.041	2.995
3,200	8.51	6.14	5.22	4.691	4.358	4.112	3.923	3.773	3.648	3.543	3.453	3.376	3.306	3.245	3.187	3.139	3.091
3,300	8.78	6.34	5.38	4.838	4.495	4.240	4.046	3.891	3.762	3.653	3.561	3.482	3.409	3.346	3.287	3.237	3.188
3,400	9.04	6.53	5.54	4.984	4.631	4.369	4.168	4.009	3.876	3.764	3.669	3.587	3.512	3.448	3.386	3.335	3.284
3,500	9.31	6.72	5.71	5.131	4.767	4.497	4.291	4.126	3.990	3.875	3.777	3.693	3.616	3.549	3.486	3.434	3.381
3,600	9.58	6.91	5.87	5.278	4.903	4.626	4.414	4.244	4.104	3.985	3.884	3.798	3.719	3.650	3.586	3.532	3.478
3,700	9.84	7.10	6.03	5.424	5.039	4.754	4.536	4.362	4.218	4.096	3.992	3.904	3.822	3.752	3.685	3.630	3.574
3,800	10.11	7.30	6.19	5.571	5.176	4.883	4.659	4.480	4.332	4.207	4.100	4.009	3.925	3.853	3.785	3.728	3.671
3,900	10.37	7.49	6.36	5.717	5.312	5.011	4.781	4.598	4.446	4.317	4.208	4.115	4.029	3.955	3.884	3.826	3.767
4,000	10.64	7.68	6.52	5.864	5.448	5.140	4.904	4.716	4.560	4.428	4.316	4.220	4.132	4.056	3.984	3.924	3.864
4,100	10.91	7.87	6.68	6.011	5.584	5.268	5.027	4.834	4.674	4.539	4.424	4.326	4.235	4.157	4.084	4.022	3.961
4,200	11.17	8.06	6.85	6.158	5.720	5.397	5.149	4.952	4.788	4.649	4.532	4.431	4.339	4.259	4.183	4.120	4.057
4,300	11.44	8.26	7.01	6.304	5.856	5.525	5.272	5.070	4.902	4.760	4.640	4.537	4.442	4.360	4.283	4.214	4.154
4,400	11.70	8.45	7.17	6.450	5.992	5.654	5.394	5.188	5.016	4.871	4.748	4.642	4.545	4.462	4.382	4.316	4.250
4,500	11.97	8.64	7.34	6.597	6.129	5.782	5.517	5.306	5.130	4.982	4.856	4.748	4.649	4.563	4.482	4.415	4.347
4,600	12.24	8.83	7.50	6.744	6.265	5.911	5.640	5.423	5.244	5.092	4.963	4.853	4.752	4.664	4.582	4.513	4.444

TABLE No. 5A

Data Applying to Wells Flowing Naturally

	Field	Depth Feet	Submergence Feet	Lift Feet	Bbl. Oil per day	Gas-Oil Ratio	Cu. Ft. Gas Required at 100%	Per Ct. Efficiency Obtained
1.	Brock, Okla.	2,000	813	1,187	1,220	1,160	55.0	4.7
2.	Cromwell, Okla.	3,400	2,210	1,190	.....	12,500	41.3	6.33
3.	Salt Creek	2,200	1,400	800	152	1,000	31.3	3.1
4.	Seminole, Okla.	4,034	1,124	2,910	4,500	707	117.77	16.6
5.	Tonkawa, Okla.	4,100	3,322	3,328	1,518	2,120	26.3	1.2

TABLE NO. 6A

Data Applying to Artificial Air and Gas Lifts

No.	Field	Depth Feet	Submergence Feet	Lift Feet	Bbl. Oil per day	Gas-Lift Factor	Cu. Ft. Gas Required at 100%	Per Ct. Efficiency Obtained
6.	Baku, Russia	1,464	694	770	1,886	134.4	43.4	32.3
7.	California	3,368	320	3,045	380	1,689	200	11.9
8.	Currie, Tex.	3,000	1,240	256	4,100	84	11.6	13.8
9.	Dominguez, Calif.	4,000	684	3,316	300	2,300	165.7	7.2
10.	Huntington Beach	4,519	718	3,801	270	3,150	189.2	6.0
11.	Huntington Beach	4,500	770	3,730	214	3,532	181.2	5.1
12.	Independence, Kans.	1,393	569	824	.....	190.7	47.38	24.9
13.	Santa Fe Springs	3,700	517	3,183	259	1,077	159.3	14.8
14.	Seminole, Okla.	3,968	450	3,518	1,680	915.6	192.8	21.1
15.	Tonkawa, Okla.	4,127	685	3,442	1,994	822	161.9	19.7

TABLE NO. 5

Per Cent Increase of Air Required to Lift 1 Gallon of Water 1,000 Feet in Addition to the Quantity Given in Table No. 4.

Alt. Ft.	100 Lbs.	200 Lbs.	300 Lbs.	400 Lbs.	500 Lbs.
1,000	2.1%	2.6%	2.8%	2.8%	2.9%
2,000	4.4	5.4	5.6	5.7	5.8
3,000	6.8	8.0	8.4	8.6	8.8
4,000	9.3	10.3	11.4	11.7	11.2
5,000	11.8	13.8	14.5	15.0	15.3
6,000	14.3	16.8	17.4	18.0	18.7
7,000	17.0	19.7	20.6	21.3	21.9
8,000	19.8	22.9	24.0	25.0	25.6

It will be noted that at high altitudes a considerably greater quantity of air or gas is required than that which would theoretically be necessary at sea level. This must be taken into account when making estimates of compressor capacity required for handling gas lift work in these higher altitudes.

Terms Employed in Gas and Air Lift Work

The arrangements that have usually been employed for piping in gas-air lift in past years is shown in Figure 1.

A represents the well casing.

B is the air pipe that is introduced into the well.

C is the casing head, or control head, through which the air pipe passes, and above which, at g, it is tightly packed to prevent leakage of air.

D is the air pipe outside the well which leads to the compressor.

E is the discharge pipe which conducts the fluid from the casing head to the receiving tank, F.

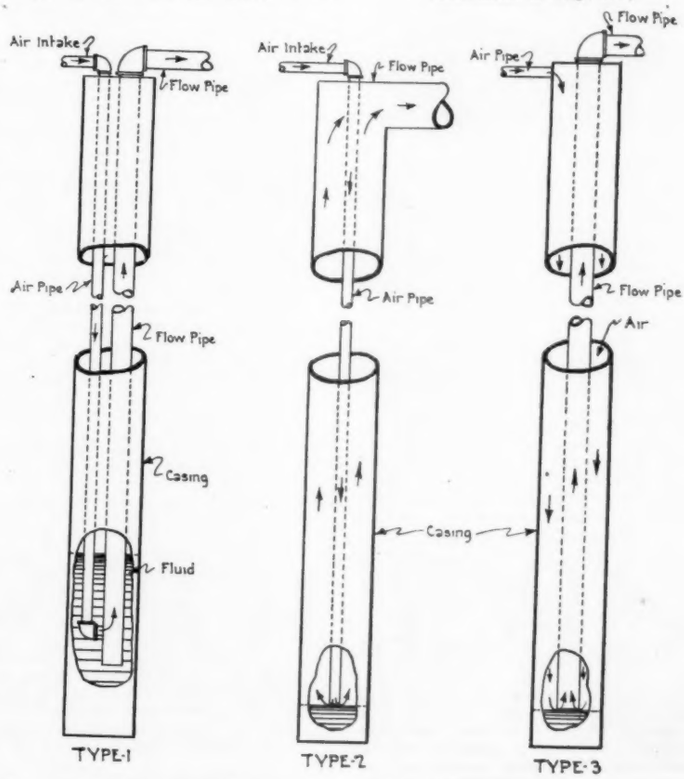
The distance l from the casing head down to the fluid level is known as the lift, or pumping head.

The distance s, from the fluid level down to the point at which the air is introduced from the air pipes to the fluid column, or flow pipe, or eductor, is known as the submergence.

The feet of submergence divided by the sum of the number of feet making up both the lift and the submergence is known as the percentage of submergence.

In most wells the fluid level will stand at a point such as b, termed the static head, before the air is admitted to the well and after beginning to flow will drop to a lower point as c, where it will remain fairly stationary, as long as pumping continues and conditions remain fairly constant. In such a case the submergence at the beginning of operations would be the head drop f, plus s, and the lift would be e, or the static head. It is necessary to ascertain the submergence f plus s, before beginning operations in order to insure ability to start the movement of the liquid at this higher point, since the pressure necessary to start operations might be greater

(Continued on Page 374)



Three general types of air or gas lift arrangements.

Magnolia Line Has Many New Features

Large Diameter Telescopic and Continuous Welded Line Has Proved Methods Employed Were Highly Successful

By James H. Dameron
Staff Correspondent, The Oil and Gas Journal

Three years ago the Magnolia Gas Co. of Dallas, Tex., started a pipe line project that has marked a new era in the construction of gas trunk lines. On June 1, 1924, a large diameter telescopic and continuously welded line was started from the Sarepta gas field in northern Louisiana and terminated at Beaumont, Tex., a distance of 217 miles. The line was built with 14, 16 and 18-inch pipe of various weights.

Such a project was the first successful attempt to weld a large diameter pipe line over a long distance and was the first time a telescopic line has been used for the transmission of gas. No better evidence of its success is demonstrated than in the fact that the same company is constructing a similar line from Louisiana gas fields to Dallas and Fort Worth, Tex., a distance of approximately 210 miles.

The radical departure from common

Neches River crossing ready to be pulled across river. Note manner of clamping pipe together. This crossing was tested to 1,000 pounds pressure and held.

practices of building long gas lines with what is known as the telescopic method and continuous welding, are not the only major factor in the Magnolia company's system that make it entirely different from other gas trunk lines. The Magnolia company's system has been designed to operate differently from any other existing gas system. Transportation of the gas through its lines is more rapid; the method of measuring the gas is different from that system of measuring gas on other main lines and the gas is marketed differently—being sold only to large consumers on a load factor basis.

Economical and Efficient

The writer might compare it to the master plants and high tension transmission lines being designed by the electrical power companies. It is apparent that even the minute details have been carefully studied from the standpoint of high-speed transmission, continuity of service, economy in operation, accuracy in measurement, and with a great paring of initial cost per mile of line.

Design of the pipe line, compressor stations, gasoline plant, measuring system and dispatching system, each reflect the most careful engineering which has made possible the rendering of continuous service to users of natural gas for industrial purposes. Because of the high pressure under which the line is operated and because of the speed with which the gas goes through the line, the designing engineer feels that the results accomplished could not have been obtained had it not been possible to weld the pipe used.

Gas is transported through the line at a speed of from 40 to 60 miles per hour and with a much higher pressure than that used in the operation of other main lines. The capacity of the line is approximately 65,000,000 cubic feet of gas daily. This is because the design of the line and the welding permit the gas to be sent through at a much higher velocity than heretofore. Cost of the line depends, of course, on the weight and size of the pipe used, but it is estimated that the cost of the Magnolia company's line ranges between $25,000 and $30,000 per mile. The weight of the pipe varies from 45 to 75 pounds and the thickness of the steel ranges from one-quarter to one-half an inch.

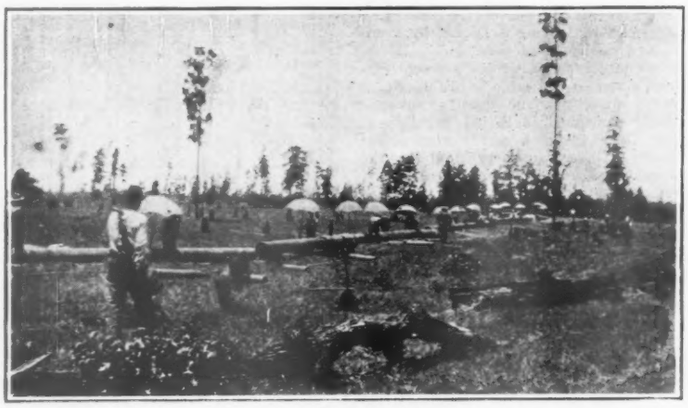
Construction of the line was carried on under unusual climatic and geographical conditions and this article will attempt to tell of the welding problems encountered and not deal extensively with other phases of the line. Appreciation is expressed to Magnolia company officials for permission granted to use construction data of the line.

Designed by Fred M. Lege, Jr.

Designing of the line from Sarepta to Beaumont and from Latex to Fort Worth was the work of Fred M. Lege, Jr., president of the Magnolia Gas Co. The construction work was handled by the Magnolia company's four general superintendents. All of the construction work was done by the company's own crews except the ditching and treating the line against corrosion. The latter was contracted to E. A. MacPherson of Fort Worth.

The decision to weld the line continuously instead of using couplers, as is common practice on other large lines, was reached after a careful study of the territory through which the line was to be built. It was held that the coupled line would not be satisfactory, due to the fact that a large portion of the line would be under water several months during each year, and because of numerous construction problems.

Miles and miles of the line goes through boggy swamps made more difficult to penetrate because of the dense growth of underbrush and trees. Numerous small streams with steep banks and three rivers had to be crossed. Only a few miles of the line goes through comparatively open and high ground. The main line was divided in three sections with each section consisting of 14, 16 and 18-inch pipe of various weights.



Welding crew at work in lowlands of Texas, using umbrellas to protect them from intense heat.

First Line an Experiment

The Magnolia company's second main line running from Bethany, La., to Fort Worth is approximately 210 miles in length and is almost an identical duplicate of the Sarepta-Beaumont line. Although the first line was more or less an experiment in the eyes of the gas industry, no major defects developed during the construction or have developed after two and one-half years of operation, to warrant any major change in the design and construction of the second line. The results obtained on the first line have been most satisfactory.

Like the first line, the second is divided in three sections, three of which consist of 14, 16 and 18-inch pipe while the other section was welded with 12 and 16-inch pipe. Unlike the country through which the first line runs, the second line has comparatively few swamps and rivers to cross. Construction obstacles presented themselves in quicksand and badly decomposed soil chopped up by numerous small creeks. The quicksand and decomposed soil played an important role in the decision to make the line a continuous welded line.

Of the many problems encountered in the welding of large-diameter pipe that of burning the joints is of paramount importance. Many of the problems encountered on large-diameter pipe welding are not common to lines with 10-inch and smaller pipe. On lines using 10-inch or smaller pipe, it has been found, the pipe being more flexible, a poorly-welded joint will hold. But the same character of weld on a larger diameter pipe would break. Because of that reason every precaution was taken to eliminate so far as possible a poor weld.

Opened Welding School

On the Beaumont line the problem of securing competent welders arose. Competent welders were difficult to find so the Magnolia company opened a welding school in the shops at the Magnolia Petroleum Co.'s Beaumont, Tex., refinery. More than 400 students were enrolled

(Continued on Page 323)

SPLENDID ARTICLES ON NATURAL GAS INDUSTRY WILL BE PUBLISHED LATER

This issue of The Oil and Gas Journal, containing 404 pages, including the covers, is the largest ever published. We were forced to limit the size of the publication to the capacity of stitching machines to handle the book.

This enforced limitation as to the size of the issue necessitated our holding many splendid articles prepared for this issue for later publication. The articles selected for publication later are fully as important and well prepared as those published in the special insert in this issue. We were guided in selecting articles for the insert solely by the desire to present as wide a representation as possible and to cover as many subjects as we could in the one issue.

Articles prepared for this special number of The Oil and Gas Journal and which will be published in later issues include the following:

"A Review of Natural Gas Measurement," by E. A. Clark.
"Economic and Engineering Problems in Estimating Natural Gas Reserves," by R. R. Brandenthaler.
"Electric Arc Welded Pipe Tests," by A. G. Bissell.
"Leakage Tests on High Pressure Natural Gas Transmission Lines," by E. L. Rawlins.
"Bibliography of Publications Relating to Natural Gas," by T. W. Johnson.
"A Survey of the Work Done by the Bureau of Standards on Gas Measuring Instruments," by H. S. Bean.
"The Parting of the Ways," by Charles S. Reed.
"Residue Gas, Its Problems and Its Benefits," by Ross M. Stuntz.
"Commercial Gas Fuels," by Lawrence Dalman.
"Leasing and Securing Rights of Way," by J. W. Kidd.
"Supplying New York With Gas," by Robert E. Livingston.
"Augmenting the Supply of Natural Gas," by Henry Clay Adams.
"Procedure Used in Keeping Well Logs," by George A. Kinley.
"Drilling for Gas With Cable Tools," by E. W. Williamson.
"Advertising and Public Relations," by C. T. Henderson.
"Testing Laboratory Aids Industry," by R. M. Conner.

The article entitled "Development of Measurement of Gas," by John C. Diehl, on page G-165 of this issue, is but a part of a most comprehensive paper on the subject prepared by Mr. Diehl. Lack of space prevented publishing the paper in its entirety in this issue but the remainder will be published in future issues of The Oil and Gas Journal.

Gasoline Manufacturers Now

KNOW

NEWTON EFFICIENCY
NEWTON ECONOMY

Recovers MORE Gasoline for LESS COST!

From the very beginning we have claimed for the Newton Process Absorption Gasoline Plant equipment GREATER operating EFFICIENCY and GREATER ECONOMY in operation than any other make on the market. That our claims were not empty boasts is a fact well known now to many proud owners of Newton equipment.

Operating from coast to coast, as well in foreign countries, Newton Process equipment, during the past two years, has performed with credit to its makers and profit to its owners under every conceivable condition known to the Industry. Tests conducted with Newton Plants have conclusively proved their ability to operate profitably on very lean gas; have proved them to be a sound investment when operating on any grade gas.

FACTS
FACTS
FACTS

Can be had from our representatives without obligation.

There is only one conclusion to arrive at from such remarkable records as have been established with Newton Plants, and the Industry IS arriving at it; Newton Process is the PROFIT PROCESS! It is the ONLY equipment that is profitable to install in lean seasons for year 'round operation. It is the ONE type of equipment that can be bought at low cost and kept operating with practically no maintenance cost.

If you are planning to install an absorption plant or additional equipment, our representative can show you how it can be done cheaper and better with NEWTON. A line to the nearest representative listed below will bring him promptly; his story will be told without obligation.

Representatives

HURLEY BROTHERS
Kennedy Bldg.
TULSA, OKLA.

THE NATIONAL SUPPLY CO.
General Offices, Toledo, O.,
and All Stores

Foreign Representatives

THE NATIONAL SUPPLY CORP.
120 Broadway
NEW YORK

MOST EFFICIENT—MOST ECONOMICAL

"Newton Process Is the Profit Process"

NEWTON PROCESS
MANUFACTURING COMPANY
FULLERTON, CALIFORNIA

The OIL and GAS JOURNAL

PRODUCING REFINING MARKETING

Published Weekly by
THE PETROLEUM PUBLISHING COMPANY
114-116 West Second Street
TULSA, OKLA.

Established as an International Publication in 1910 by Patrick C. Boyle

President - - - - - - - - - - - - Frank T. Lauinger
Vice President and General Manager - - Robert W. Egan
Secretary-Treasurer - - - - - - - - - - W. T. Bryan
Editor - - - - - - - - - - - - - James McIntyre
News Editor - - - - - - - - - - Andrew M. Rowley
Associate Editor - - - - - - - - - - W. T. Anderson
Refinery Editor - - - - - - - - - - - C. O. Willson
Technical Editor - - - - - - Charles K. Francis, Ph.D.
Advertising Manager - - - - - - - - Clarence Morris
Circulation Manager - - - - - - - - - J. P. Mulkern

DISTRICT ADVERTISING OFFICES

C. L. CAIN - - Room 629, 101 Park Ave., NEW YORK CITY
E. KLAPPENBACH, 1328 Peoples Gas Bldg., CHICAGO, ILL.
C. F. TOPE, 421 Union Mortgage Bldg., CLEVELAND, OHIO

TERMS OF SUBSCRIPTION
(By Mail, Postage Prepaid)

Single copies - - - - - - - - -	$ .15	One year (in United States) - - -	$6.00
Three months - - - - - - - - -	$2.00	One year (in Canada) - - - - - -	$7.00
Six months - - - - - - - - -	$3.00	One year (foreign countries) - - -	$7.00

ADVERTISING RATES ON APPLICATION
Telephones: 6291-6292-6293
Remittances by Checks, Drafts, Express or Postal Money Orders should be made payable to
The Petroleum Publishing Company
Cable address, "Oilgasnal"

MEMBER AUDIT BUREAU OF CIRCULATIONS

GASOLINE AND CRUDE PRICES

One of the things it is hard to get the public to understand is, why, with such an overproduction of crude oil, is there not a flood of cheap gasoline?

Even some oil producers, unfamiliar with the operations of the manufacturing division of the industry, fall into the same error.

It is a common mistake to jump to conclusions regarding finished products because raw material may be abundant. Freight, taxes, overhead expenses, sales and distribution costs, as well as the cost of operating the manufacturing processes, are forgotten, yet these remain the same no matter how much cheaper the raw material may become.

The cost of raw material is no indication of the value of many a finished product in general use. A city may get its water supply from a nearby river or lake, as free as air; what the consumers have to pay for is its distribution. The difference in cost between steel rails and a watchspring has nothing to do with the cost of the raw material. It is a manufacturing cost difference.

The popular notion that oil spouts out of the ground and that getting gasoline out of the oil is about as simple is chiefly responsible for the idea that gusher production should mean gasoline for next to nothing at the pump.

Congressmen may be interested in the fact that if crude oil were given away at the wells in the Mid-Continent Field no one could retail gasoline in the National capital for less than 14 cents a gallon and come out even on it.

Crude oil, the raw material from which our motor fuel is manufactured, represents less than one-fourth the price of gasoline at the filling stations.

Why, at the present rate of increase in taxes on gasoline, it will not be long until the tax per gallon costs more than the crude. On June 1 the price of the average grade of crude was 3.14 cents per gallon and the average gasoline tax in 50 representative cities was 2.75 cents per gallon.

Some states now have a 5-cent a gallon tax on gasoline and several have a 4-cent and many a 3-cent a gallon tax.

That shows how much of a figure the cost of crude cuts in the price of gasoline at the pump.

Those who think that the overproduction of crude should be reflected in gasoline given away for a song should think this over.

But, despite that, the facts prove that gasoline actually has been reduced as much as crude.

June a year ago the price of Mid-Continent crude at the wells was the highest for the year, averaging 5.83 cents a gallon. Today it is 3.14 cents a gallon, a reduction of 46 per cent or 2.69 cents a gallon. Almost as much, it may be noted, as the average gasoline tax.

A year ago the average retail price in 50 representative cities was 22.03 cents a gallon. Today it is 18.10 cents a gallon, a decline of 3.93 cents.

In other words gasoline has been cut 1.24 cents a gallon more than crude and in addition the refiners and distributors have absorbed an increase of 0.27 cent in road tax!

So that the answer to the question why gasoline has not been cut as much as crude is that it has been and then some, although the cost of crude is less than one-fourth the price of gasoline at the station, the other three-fourths being made up of taxes, freight, manufacturing and distributing costs which do not fluctuate.

There are gathering and pipe line charges, water and rail freight, retail delivery, road and inspection taxes which are not affected by the overproduction of crude.

Gasoline, kerosene, gas oil and fuel oil make up 90 per cent of the products from petroleum. The record shows that within a year they have declined 44 per cent or almost exactly the percentage of reduction in the cost of the raw material.

It is facts like these that the industry ought to get before the public to correct mistaken ideas and to set itself right with the people.

But the different divisions of the industry are so engrossed in their immediate interests that they do not get a complete picture of the industry's operations.

Producers not interested in refining are apt to think that if there were cheaper gasoline there would be greater demand, making inroads on stocks and helping the crude market. Yet the figures show that gasoline is at rock bottom, that it has reflected the reduction in crude and more, and that it is worth far more than it is being sold for.

Knock off the state tax on gasoline and the freight and see what gasoline is selling for. The price at the service stations represents an advance above what the industry gets for it over which the industry has no control. But the public seldom, if ever, stops to analyze that and charges the whole sum to the oil business.

Yet the facts are so plain and their demonstration so simple that they can be understood by anyone.

Oil companies are spending millions advertising their products along the same lines as clothing or soaps or cigarets when the greatest need is to convince the buying public of the good faith of the oil business.

Every gasoline price war, every gusher reported, is twisted into a popular misunderstanding which is directed against the oil industry.

If there is a period of overproduction of crude it is used to create the impression that the industry is taking advantage of it in gasoline prices even when the facts are exactly the opposite and easily proved.

Here is an excellent opportunity to show the public the truth and give the people a clear view of the whole situation.

Within the past few years the industry has made great progress toward co-operation of its units, in the producing division, in standardization, in uniform accounting, and in the exchange of information on new methods and processes. It should be possible to extend this co-operation to a general movement for the education of the public against current misconceptions of the operations of the industry.

At the same time it would enlighten the industry about its own business and prepare the way for greater co-operation to come.

As Durable as the Oaks above them-

DRESSER

COUPLINGS Dominate

S. R. Dresser Manufacturing Co.
Bradford, Penna.

View of a Hope Natural Gas Company line which employed more than 60,000 Dresser Couplings

Oil "Joker" in Arms Limitation Pact

United States May Seek Revision of Clause Affecting Storage in Philippines at Geneva Next Monday

By Charles E. Kern
Washington Bureau, The Oil and Gas Journal

WASHINGTON, D. C., June 14.—The time has come when the oil industry of the United States should be called upon to lend its expert advice to all discussions between nations relating to a limitation of armament in which the United States becomes a party.

No better proof could be submitted than the terms of the agreement adopted by the Disarmament Conference that met in Washington, as a result of the formal invitation of the President, August 11, 1921, to the Governments of Great Britain, France, Italy, and Japan to participate in a conference on the limitation of armament.

Astounding as it may appear, the other nations managed so to word the treaty resulting that they absolutely tied the hands of the United States from storing oil in the Far East in any considerable quantity, while they left themselves with practically an inexhaustible supply of this most necessary material of naval warfare. This result was accomplished in a very clever manner without ever mentioning storage tanks, petroleum or mineral oil or fuel oil by name. It is doubtful whether the representatives of the United States really understood the language they were accepting to bind this country until December 31, 1936.

It is not contended that the American naval experts were ignorant of these facts but all experts were there simply to give advice and the final compromise did not necessarily require their assent or even their knowledge of the details.

After the conference had adjourned it was discovered that the American navy was bound, at least in the opinion of the British officials, not to elevate the guns on American war vessels to give them the same range enjoyed by the British navy with its guns already elevated. No one will contend that any representative of the United States navy ever consented to an arrangement of that kind and its existence in the treaty has always been looked upon as in the nature of a mystery and brought about through those devious methods of diplomacy which juggles words and paragraphs to suit its own ends.

America at Disadvantage

But, even more important, is the fact that in the final acceptance of the treaty, unlimited reserves of oil were left under the control of the other negotiating powers, while the United States solemnly entered into a covenant which, in the interpretation given it by people in authority and who ought to know, made it impossible to provide storage for fuel oil in the Philippines to keep its bunkers filled long enough to carry on any considerable activity.

All this was accomplished in the following innocent-looking paragraph:

"Par. 4: The maintenance of the status quo under the foregoing provisions implies that no new fortifications of naval bases shall be established in the territories and possessions specified; that no measures shall be taken to increase the existing naval facilities for the repair and maintenance of naval forces and that no increase shall be made in the coast defense of the territories and possessions above specified. This restriction, however, does not prevent such repair and replacement of worn out weapons and equipment as is customary in naval and military establishments in time of peace."

It will be observed that this paragraph provides that no measures shall be taken to increase the existing naval facilities for the repair "and maintenance of naval forces." The building of additional oil storage facilities would be regarded as an increase in "the existing naval facilities for the repair and maintenance of naval forces." It is true it is believed that this provision would not be violated if existing coal bunkerage facilities were replaced by an equivalent amount of oil bunkerage but that would be trifling in volume.

Joker in Transaction

This provision, of course, binds all other parties to the treaty but the joker to be found in the entire transaction is found in the fact that Great Britain has, just outside the geographical limits affected by this treaty agreement, not only millions of barrels of fuel oil in storage but supplies of petroleum that may be regarded as inexhaustible for carrying on any sort of naval conflict that might suddenly arise to place the Philippine Islands in jeopardy. They have at their command the oil of Burma, Java, Sumatra and Borneo. In other words, the United States is restricted from having any supply of petroleum in the Philippines in tanks, while the British Empire has an unlimited quantity of oil in storage in tanks and in the ground in these near-by and convenient supply stations. It is quite interesting to note that at both Cavite and Olongapo our naval fuel oil supply amounts to about 110,000 bbls. which is exactly two oil tanks of 55,000 bbls. each. In addition to that our commercial storage at these ports amounts to about 250,000 bbls. These 350,000 bbls. would be consumed by a naval fleet on scouting duty so that, by the time any real naval action should be deemed necessary, the bunkers would be empty.

10,000 Miles Away

The only oil fields from which our naval vessels could be supplied with fuel oil would be 10,000 miles away in California and that would be the dependence of the American navy unless the oil storage at Pearl Harbor needed for other purposes should be resorted to and that would be nearly 7,000 miles fro the seat of action. At Pearl Harbor there is something like 4,500,000 bbls. of fuel oil stored for the navy in tanks, built chiefly by the Doheny interests when the Government was exchanging fuel oil for storage and, in addition to that, there is at that place about 500,000 bbls. of fuel oil in commercial storage. At Guam there is no American storage at all.

The Geneva Conference will meet next Monday, June 20, to consider arms limitation relating to lesser craft than was the subject of the arms limitation conference in Washington. Of course the treaty relating to a maintenance of the status quo in the Far East was a sort of side show to the general arms limitation treaty and it went far beyond what anybody supposed would be done when the conference was called. It appears to have been an expedient for reaching an agreement on arms limitation.

No one ever supposed that anything would be done to hamper United States naval forces in maintaining a proper supply of fuel oil in the Philippine Islands, when the discussion began with the object of limiting the building of battleships. The thought at that time was that the whole world was exhausted and that it was a good time, temporarily at least, to put an end to the construction of these expensive craft, but no one ever dreamed that we were putting an end to our ability to supply a naval fleet in the Far East with all the fuel oil necessary from our own oil storage tanks in the Philippine Islands.

Oil All Important

Just as it is said that "an army travels on its stomach," so it is true that a navy travels on its oil bunkers. After the World War was over it was proclaimed that the Allies and the United States had "floated to victory on a sea of oil." The fact is that, if one necessary portion of the supplies needed by the navy could be placed above all others, it is the oil supply. This condition appears in the guise of a fateful irony which has given the United States three-fourths of all the petroleum of the earth in respect to its production and yet has wholly paralyzed its ability to supply in tanks a sufficient quantity of fuel oil in the Philippines or anywhere else in the Far East to keep its navy afloat there for any considerable length of time.

It seems useless to expend thought in bewailing this oil famine which has been deliberately wished on the United States in the Far East but it should be remembered that the Geneva Conference, like the Arms Limitation Conference in Washington, may take up subjects that no one contemplated when the conference was called. There was no thought when the Arms Limitation Conference was called in 1921 of any agreement respecting the status quo in the Orient. No American ever contemplated, even when the treaty was reported and agreed to, the position in respect to the fuel oil supply that the United States has actually experienced.

Our Chance at Geneva

So it might be that the Geneva Conference, that proposes to consider arms limitation in respect to craft less than battleships, that is, cruisers, destroyers, submarines, etc., might undertake agreements not contemplated at this time. It seems unthinkable that any such agreement should affect the fuel oil supply of the world, and especially the natural advantages that the United States has at this time in possessing the bulk of the production of petroleum, but that there

(Continued on Page 363)

PRESIDENT W. G. SKELLY GIVES VIEW OF PETROLEUM EXPOSITION BOARD

President W. G. Skelly, of the Skelly Oil Co., and president of the International Petroleum Exposition scheduled to be held at Tulsa, September 24 to October 1, has written the following letter to The Oil and Gas Journal:

The Oil and Gas Journal:

I read with some interest your editorial of May 12 with reference to holding the Petroleum Exposition this year.

As you know, I am president of this institution, and along with other citizens, have, and do take a keen interest in the welfare of this exposition, because I realize its great value to the oil industry.

I want you to know that I thoroughly appreciate the sincerity of your objections to holding the show this year, although I cannot concur in them. I want to further tell you that I appreciate the great value of The Oil and Gas Journal to the industry and to the International Petroleum Exposition.

Realizing this as I do, and because I would like to see The Oil and Gas Journal in full accord with the unanimous opinion of the board of directors of the Exposition, I am, after considerable deliberation, writing to you setting forth the views of the directors and many others in the industry with whom I have consulted in this matter.

I cannot help but feel that you were misinformed relative to the activity of the Tulsa Chamber of Commerce in urging the exposition for this year, because I personally know that the Chamber of Commerce acted only at the suggestion, and with a view to aiding the directors of the Petroleum Exposition in carrying out a program that they themselves, after considerable investigation, had finally decided was for the best interest of the oil industry at this particular time.

I can realize how this mistake could be made, because the Chamber of Commerce was used as the vehicle for the public announcement of the decision of the exposition board to hold the oil show this year.

At the inception of the oil exposition in 1923 I must confess that I could see little advantage to the industry in such an organization. More out of civic patriotism and a desire to go along with the rest of the fellows, I joined in. I soon realized, however, from reports that I received from our field men, what great economic advantage we had found through their inspection of modern methods, which in the ordinary course of

W. G. SKELLY
President, International Petroleum Exposition

business, pressed with the daily task, we had not been able to grasp.

At that time, as you know, the oil market was much higher; profits were greater and the opportunity for analyzing costs in order to insure a profit, had not been forcefully brought to attention.

In considering the advisability for an exposition this year the necessity for further economy in operating costs was the dominating factor in the mind of the board. We are living in a rapid age when mechanical improvements come daily. Surely, we felt, there was opportunity and reason in a decision to again

(Continued on Page 361)

Extend Hughes Area, Upton County

Well Making 36 Bbls. an Hour. Eleven New Rigs in Church-Fields Pool. Deep Sand in Callahan County

By C. D. Lockwood
Staff Correspondent, North and West Texas

FORT WORTH, Tex., June 13.—A half mile south extension to production in the Hughes district of Upton County flowing 35 bbls. an hour in an area which is separated from the main trend by small wells, and the building of 11 new rigs along the Landreth strip in the Church-Fields Pool of Crane County, bringing the total number of tests in that "Midway" district to 29, featured the week in West Texas. Ninety-three producers in the Church-Fields and Gulf-McElroy Pools averaged 46,608 bbls. daily during the past week, or almost exactly 500 bbls. per well. The Yates Pool in Pecos County is shut in again, due to storage difficulties, so the average for the week was only 6,895 bbls., as compared with 13,636 bbls. during the previous seven days. It is due for a further slump next week, too, unless the wells are opened up for a day or two. The production on Sunday was 5,107 bbls. from seven wells, with the largest choke one-half inch in size. Deliveries were also cut down to 5,194 bbls., and have been at that low mark for several days. Last Saturday the Illinois Pipe Line Co. had 14 miles of its 8-inch laid and should have the other 13 miles completed by the first of next month.

Production Drops

Estimated production dropped off in practically all divisions of the North and West Texas territory this week. The Big Lake Field declined 660 bbls., as did nearly all of the West Texas counties, with the exception of Crane and Upton, where the combined increase amounted to near'y 5,000 bbls., and was sufficient to cut the loss down to 3,700 bbls. Brown County also slumped again and brought the entire Ranger-Eastland district down with it, the decline amounting to a little more than 1,000 bbls. This was due to the lack of sufficient new flush production to offset decline in the old, which is rapid. There was nothing new in the Wichita Falls district, this week to offset normal declines, and so that district showed a loss of 1,600 bbls. The total decline of North and West Texas was 6,429 bbls., or almost exactly the drop in Pecos County alone. If the Yates Pool wells were allowed to flow part way open, the gains in Crane and Upton Counties would have offset other losses and the estimated output would have remained practically stationary. A number of wells in good territory in the Upton-Crane area are near the pay depth and will be completed during the next two weeks, but may not affect production next week.

Upton Extension

The south extension in Upton County referred to above is Humble Oil & Refining Co.'s No. 5 Ricker, located 2,310 feet from the northeast line and 4,600 feet from the northwest line of Section 5, Mary S. Denton Survey. It topped the pay at 2,155 feet and found the big pay at 2,255-68 feet, where it flowed 830 bbls. in the first 23 hours, and during the 71 hours ended at 7 o'clock Saturday morning averaged just a little less than 36 bbls. an hour. About 2,000,000 feet of gas accompanies the oil, which tests 30 degrees gravity and contains no water. The wells along the north line of this lease were small producers, and No. 3 was recently abandoned at 2,530 feet. This well, half a mile south, opens possibilities of a new trend, although it is understood that Humble doesn't intend to drill offsets immediately. The company owns the entire section.

WILDCAT OPERATIONS IN WEST TEXAS

Week Ending June 11.

Company, Farm and Location—	Remarks—
ANDREWS COUNTY	
Calvin & Belt's No. 1 Ratliff & Bedford, C NE Sec. 16, Blk. A-54	Location.
J. S. Cosden's No. 1 Ratliff & Bedford, C SE Sec. 8, Blk. 73, Public School Land	Spudded and shut down.
Sartain Oil Co. et al's (was Deep Rock Oil Co.'s) No. 1 W. J. Harris, C SE Sec. 12, Blk. A-46, Public School Land	Shut down 100 ft.
C. B. McKennon's (was Neff et al's) No. 1 J. S. Means, C SE Sec. 12, Blk. A-35, Public School Land	Spudded 30 ft. and shut down.
A. G. Carter & Zweifel's No. 1 Cowden, C SE Sec. 18, Blk. A-52, Public School Land Sur., elev. 3,156 ft.	Top salt 1,375 ft.; cleaning out 3,285 ft.
Maer & Staniforth's No. 1 W. B. Taylor, C SE Sec. 15, Blk. A-42, Public School Land Sur., elev. 3,215 ft.	Top salt 1,650 ft.; drilling 3,560 ft.; little gas from 3,010 ft.
BORDEN COUNTY	
J. L. Kennedy's No. 1 J. S. York, SE cor. Sec. 322, Blk. 97, H. & T. C. Sur.	Fishing tools 980 ft.
Stivers et al's No. 1 Snodgrass, C NW Sec. 475, Blk. 97, H. & T. C. Sur.	Shut down 3,000 ft.; lime; contract depth.
BREWSTER COUNTY	
McPhail & Kemper's No. 1 McIntyre, SE cor. Sec. 31, Blk. 352, 7 mi. S of Alpine	Shut down 215 ft.
COKE COUNTY	
Danciger O. & R. Co.'s No. 1 Mrs. Byrnes, Clinton Sur.	Shut down for casing 602 ft.
Lipan Oil Co.'s No. 1 S. M. Conner, Sec. 71, Blk. 2, H. & T. C. Sur.	Shut down 1,215 ft. for 10-in.

(Continued on Page 365)

Tidal Oil Co. obtained a good well offsetting the Snowden & McSweeney producer in the William Teer Survey, Section 4. It flowed 300 bbls. at 2,296-2,301 feet. Gulf Production Co. topped the gray lime at 2,063 feet in its offset to the same well, No. 1 Hughes-B, and was drilling at 2,075 feet Sunday. White Eagle is also nearing the pay in its No. 1 Hughes, the third offset.

In the Allie Lane region, the Dixie Oil Co.'s No. 25 Burleson offset to the Gulf's No. 1 Lane increased to 800 bbls. with no water, when deepened to 2,035 feet. Top of pay was 1,950 feet. The Texas Company's No. 1 Perry in the same district flowed 337 bbls. Sunday at total depth of 2,041 feet, and the Prairie and Gulf producers are continuing to hold up in good shape. It looks as though the best part of this extension will probably be found to the north of the present wells on property owned by the Gulf Production Co.

Church-Fields Pool

Eleven new locations have been made in the Church-Fields Pool of Crane County as a result of the Gulf Production Co.'s big well, which was recorded last week, and three other West Texas counties each reported one new location, making 14 for the district during the past seven days. The Gulf's big well, No. 12 J. T. McElroy, flowed 13,995 bbls. in four days, from June 8 to 11, inclusive, with the tools in the hole, the drilling line having parted while the tools were hanging at a depth of 2,000 feet. Total depth of the hole is 2,840 feet. Gulf's No. 11 was completed for 690 bbls. at 2,910 feet, the shot record having been reported last week.

Carl Cromwell and Frank Pickrell's No. 5 University was shot with 160 quarts from 2,901-55 feet and responded with a flow of 825 bbls. during the 24 hours ended at 7 a. m. Saturday. Before the shot it was making 499 bbls.

Landreth Production Co.'s No. 1 Cowden-Anderson topped the pay at 2,780 feet, and at 2,850 feet flowed 215 bbls. the first 24 hours. It was still drilling and should make a much better well. This offsets the Gulf's No. 11 and Cromwell's No. 5. Simms and Atlantic's No. 2 University-D, SE cor. Section 46, Block 30, swabbed 30 bbls. Saturday from pay topped at 2,797 feet and drilled to 2,890 feet.

Gulf Production Co. is building six new rigs along the Landreth strip. No. 17 is 771 feet south and 1,320 feet east of NW cor. Section 200; No. 18 is 200 feet south and 990 feet west of NE cor. Section 201; No. 19 is 771 feet south and 12 feet east of NW cor. Section 200; No. 20 is 200 feet south and 1,650 feet west of NE cor. 201; No. 21 is 771 feet south and 660 feet west of same NE cor.; and No. 22 is 771 feet south and 660 feet east of NW cor. Section 200.

Simms and Atlantic's No. 3 University-D is one location north of No. 2, which is in the SE cor. of Section 46, Block 30; and No. 4 is one location west of No. 2. No. 5 is one location west of No. 4. Landreth's No. 7 and No. 8 are west of his No. 2, which is his farthest west drilling well and an offset to Gulf's No. 12 McElroy.

NORTH CENTRAL TEXAS
Estimated Production
Week Ending June 11, 1927

Ranger District—	June 4	June 11
Brown County	25,205	24,420
Callahan County	4,525	4,365
Coleman County	1,185	1,175
Comanche County	1,595	1,575
Palo Pinto County	450	400
Ranger	9,610	9,550
Shackelford County	7,630	7,625
Stephens County	10,070	10,045
Total Danger district	60,270	59,155
Wichita Falls District—		
Archer County	29,000	28,200
Baylor County	100	95
Clay County	775	705
Cooke County	3,740	3,695
Jack County	685	640
Montague County	12,470	12,440
Throckmorton County	2,145	2,110
Wichita County	32,205	31,990
Wilbarger County	13,030	13,000
Young County	12,730	12,405
Total Wichita Falls dist.	106,880	105,280
Total North Central Texas	167,150	164,435
West Texas District—		
Big Lake Field	26,340	25,600
Crane County	45,306	48,030
Crockett County	1,949	1,216
Ector County	15	18
Garza County	1	1
Glasscock County	36	36
Howard County	3,410	3,306
Jones County	1,931	1,765
Loving County	20	25
Mitchell County	3,909	3,656
Pecos County	13,636	6,895
Scurry County	21	19
Upton County	18,372	20,252
Winkler County	777	1,190
Total West Texas district	115,723	112,009
Grand total N. & W. Tex.	282,873	276,444

Interesting Wildcat

An interesting wildcat location is Wise & Jackson's No. 1 McElroy in the SW cor. of Section 184, Block E, C. C. S. D. & R. G. N. G. Survey, on the Upton County side of the line and nearly 2 miles east of production in the Gulf-McElroy Pool. It is located on a 40-acre tract entirely surrounded by Gulf Production acreage.

The Gulf-McElroy Pool is being electrified through the extension of transmission lines northwest from McCamey by the West Texas Utilities Co. Motors are being installed at all pumping wells and a substation has been completed in the field.

The Jones County wildcat, Midwest Exploration and Campbell's No. 1 Hern-

(Continued on Page 363)

Late News from the Fields

OKLAHOMA

A disappointment in the Earlsboro sector of Seminole is the Barnsdall Oil Co.'s No. 2 Davis, NE cor. SW Section 11-9-5, which is a quarter mile west of the Magnolia Petroleum Co.'s No. 1 Holmsley, the well which opened this part of Earlsboro. The Davis well had the Wilcox sand 4,322-4,327 feet, with 2,000 feet of water and some oil, and when placed on the swab it made 229 bbls. in 24 hours, and the oil was cut 7 per cent.

Independent Oil & Gas Co. and Devonian Oil Co.'s No. 1 Day, NE cor. NW Section 21-9-5, found 400 feet of oil in the Viola lime at 4,504 feet and found the Wilcox sand dry at 4,516 feet.

One of the surprises of the Searight Pool was Roxana Petroleum Corp.'s No. 1 Strothers, NW cor. SW NE Section 3 9-6, which started flowing 185 bbls. an hour from the Wilcox sand, 4,361-4,372 feet, and made 4,368 bbls. the first 24 hours. This was a good Hunton lime well, making 500 bbls. from the latter formation.

In the Atlantic Pool, Osage County, The Texas Company's No. 4, SE cor. NW Section 30-25-8, made 475 bbls. from the Burgess sand, 2,422-2,448 feet.

The Greater Seminole Field is again close to its former peak, and on Monday of this week made 372,510 bbls. from 511 wells, and on Tuesday 371,578 bbls. from 515 wells.

Shaffer Oil & Refining Co.'s No. 2 Lacey, NE cor. SE SW Section 14-8-6, in the Bowlegs district of Seminole, made 2,000 bbls. the first 24 hours after being placed on the air-gas lift. The sand in this well was found 4,152-4,175 feet.

GULF COAST

HOUSTON, Tex., June 14.—The Yount Lee Oil Co.'s No. 15 fee, at Spindletop, is flowing 2,000 bbls. at 5,970 feet.

The Gulf Production Co. has started No. 12 Moore in the Orchard Pool in Fort Bend County, where that company has all the acreage within the limits of the field.

The Gulf company is rigging No. 1 Burt and Griffith in the Humble Pool for a deep test. The Atlas Oil Co. is starting No. 2 Fondren there. Old leases have changed hands and been worked over, thus maintaining the daily average for the pool. The Rolyat Production Co. has acquired the old Cherry property and has developed a production of 140 bbls. per day from 11 wells.

Gas Well Burning

The Rio Bravo Oil Co.'s No. 3-B Settegast, on the northwest side at Pierce Junction, has been burning since early Saturday morning. It is an old hole that was being drilled deeper around 4,000 feet when the bit dropped into a sand showing oil and gas. The gas ignited. It is estimated as high as 30,000,000 feet

(Continued on Page 365)

New Pool Looms in Moore County

A. D. Morton & Co. Find Oil in Northeastern Part of County. Panhandle Production Takes 7,700-Bbl. Drop

By James H. Dameron
Staff Correspondent, Texas Panhandle Fields

AMARILLO, Tex., June 13.—Discovery of a new pool in the Panhandle Field loomed during the past week when A. D. Morton & Co.'s No. 1 Reeder, SW NW NE, Section 191, Block 3-T, T. & N. O. Survey, northeastern Moore County, found oil pay at 3,370-72 feet and flowed 40 bbls. over night after being deepened 7 feet. The well is in rank wildcat territory and is the second well to find oil in Moore County.

While the wildcat was the principal well of interest to Panhandle operators no fast acreage trading followed the encouraging developments of the well. One reason for the comparatively slow trading in acreage was because of the fact that the majority of the leases for miles around the well are held by major operators.

Elevation of the well is 3,516 feet and by steel line measurement the pay was topped at 3,370 feet and penetrated 2 feet. More than 1,700 feet of oil rose in the hole overnight and the well made 55 bbls. of 33.7, corrected gravity, oil on the swab the following morning when it was run three or four times.

Operations were shut down and additional tankage built. Late in the week the hole was cleaned out and the sandy lime pay deepened 7 feet to 3,379 feet. Oil rose more rapidly in the hole after deepening and during the night the well flowed 40 bbls. Previous to that the well made 35 bbls. on the swab in two hours. Two 250-bbl. tanks and one 500-bbl. tank are on the lease at present. It is reported that it is probable the well will be shut down until additional storage is created.

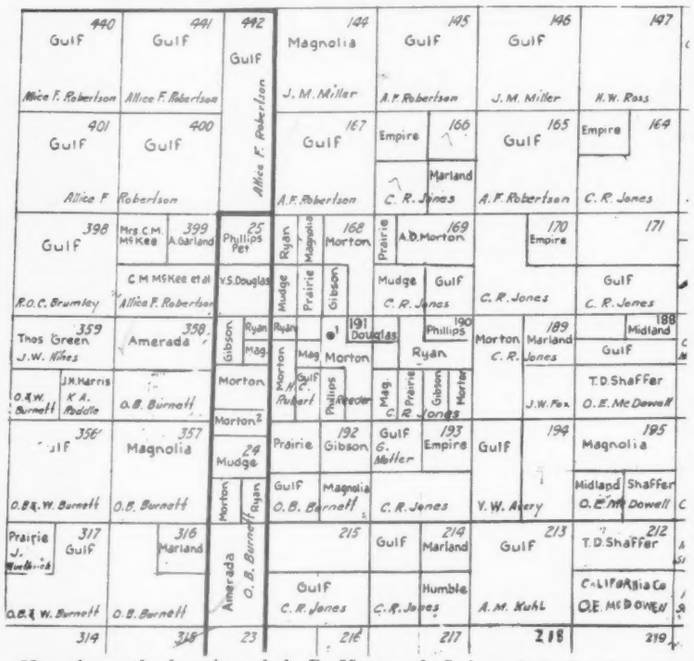
Early in the week a slight showing of oil was found at 3,325 feet. No. 1 Reeder had 70,000,000 feet of gas at 2,805-55 feet, which was killed. On the strength of the big gas, A. D. Morton, Bartlesville, Okla., and president of the Morton company, obtained a franchise to supply a near-by town with gas from the Moore County well. It is reported he will drill another well to the gas-producing horizon if No. 1 Reeder is completed as a commercial oil producer. Otherwise the well will be plugged back and the gas saved.

It was reported Monday that the Prairie Oil & Gas Co. plans to run a line from the Merchant Pool in Hutchinson County to the Morton & Co. wells, but this report was not confirmed. The Merchant Pool is north of the Canadian River and the wildcat well is approximately 25 miles to the northwest. Running direct to the Morton & Co. well the line, if laid, would pass close to the Cadman & Martin No. 1 Sneed, Section 68, Block 3, which is a few miles west of the Hutchinson County line.

The latter well is a producer and was drilled some time ago. Because of its remoteness and the inability to profitably take the oil off the lease, the well has been shut in. It is reported that around 12,000 bbls. of crude is in storage on that lease.

Surface Conditions Good

Surface conditions for drilling around the Morton & Co. well are ideal, being a wide flat country. The well is just a few miles northeast of Dumas. The wildcat find has stimulated interest in numerous other blocks in Moore and adjoining counties. The Morton block was assembled in February and several major companies bought spreads around the well. Gulf Production Co. holds the most acreage for miles around the well. That company has approximately 18,000 acres spotted around the well. The largest block of acreage is the Gulf company's block comprising several sections to the northwest.



Map shows the location of A. D. Morton & Co.'s well in Section 191, Block 3-T, T. & N. O. Survey, about 8 miles northeast of Dumas, county seat of Moore County, and the acreage ownership close to the well. This well is believed to have opened a pool. The map is used through the courtesy of the Heydrick Mapping Co., Wichita Falls.

Deep Dry Hole in Parmer County

In Parmer County, the Humble Oil & Refining Co.'s No. 1 Farwell, was stopped at 3,503 feet and the crew was ordered to plug and abandon the test. The Humble company's test was the only drilling operation in that county.

Wheeler County's big gas well, Watchorn Oil & Gas Co.'s No. 1 F. E. Shelton, C NE NE, Section 22, Block 24, is drilling ahead at 2,007 feet. The well was making 200,000,000 feet of gas from 1,905-26 feet. It was one of the Panhandle's largest gas wells.

In Gray County three tests were being followed with interest. Empire Gas & Fuel Co.'s No. 1 J. F. Meers, NE SE. Section 107, Block 3, has 2,000 feet of oil in the hole from lime and granite wash at 2,780-2,810 feet and 3,110-16 feet. Storage has been erected and an early test is expected.

Gladys Gray Oil Co.'s No. 1 Colebank-Morse, Section 89, Block B-2, was plugged back from 2,905 feet to 2,504 feet and shot. The well was bailed dry and 500 feet of oil rose in the hole in 12 hours. Rensaul Petroleum Co.'s No. 1 M. Huselby, Section 55, Block 25, flowed 36 bbls. the last 24-hour gauge available, from granite wash topped at 2,407 feet. The bit was lost and the test is being delayed by the fishing job.

Shallow Showing in Hale County

Hale County's second test, Engleking Drilling Co.'s No. 1 Mullican ranch, Section 21, Block B, R. M. Thompson Survey, 10 miles west of Hale Center, is reported to have a shallow showing of oil that is causing some excitement. The first shallow showing was found at 430 feet and the second at 470 feet. The well has been shut down at 585 feet for several days and according to reports there is 300 feet of fluid in the hole with 30 feet of b.s. on top.

The Cockrell Pool in Hutchinson County is not proving a serious threat. Several wells have been brought in there within the past few weeks but none have been sensational. One 1,250-bbl. well was completed in that pool last week.

Several weeks ago McIlroy Oil Co.'s No. 2 E. Cockrell, Section 4, Block B-3, was completed capable of making a little better than 500 bbls. per hour. The well was pinched in. It was the record gusher of Panhandle. Formerly the Lucky Ten Oil Co.'s No. 1, in Section 11, Block Y, held the record when it came in as a 10,000-bbl. well. However, that well's production was not sustained. It went dead and was revived several times and finally completed as a good commercial producer. The well is still producing.

Gas Activities

Activity in the gas industry in Panhandle is brisk. Franchises for small towns in the area are being sought daily and plans for short lines are being made. The Empire Gas & Fuel Co. has 80 miles of pipe strung north from Pampa on its Panhandle-Kansas City, Mo., gas line.

The third fatal fire within two weeks claimed another life last week when Empire Gas & Fuel Co.'s No. 1 Archer, Section 174, Block 3, Gray County, was ignited when gas production at 3,302 feet was found. Earl Lee Masters, tool dresser, was burned to death. His charred body was recovered when the fire was extinguished 1½ hours later.

New locations reported early this week for the Panhandle are as follows:

Hutchinson County

Thirty-three completions were turned in from Hutchinson County during the week, however, several of that number were abandoned locations and rigs temporarily abandoned.

Brookins and associates' No. 1 Johnson Brothers, Section 22, Block Y, is an abandoned location. Derby Oil Co. and associate's No. 2-A Johnson Brothers, Section 22, Block Y, was drilled to 2,960 feet and plugged back to 2,942 feet. Lime at 2,855 to 2,942 feet was shot with 210 quarts and the well responded flowing 400 bbls. The cellar for Cockrell-McIlroy Oil Co.'s No. 1-K E. Cockrell, Section 1, Block B-3, was abandoned. Derby Oil Co. and associates' No. 4-A Johnson Brothers, Section 22, Block Y, was plugged back to 2,942 feet from 2,960 feet; lime at 2,884 to 2,942 feet shot with 100 quarts and the well started off flowing 170 bbls.

Rigs for four wells were taken down by the Dixon Creek Oil Co. Nos. 43, 44, 46 and 47 H. E. Smith, all in Section 11, Block Y, M. & C. Survey, were abandoned. First National Oil Co.'s No. 1 E. Cockrell, Section 3, Block B-3, D. & S. E. Survey, topped the pay in lime at 2,963

(Continued on Page 355)

WILDCAT OPERATIONS IN PANHANDLE

Week Ending June 11, 1927

ARMSTRONG COUNTY

Company, Well, Farm Name, Section and Block—	Remarks—
Meadows et al's No. 1 E. D. Harrell	Location.
United Oil & Trust Co.'s No. 1 J. P. Reck, Sec. 162, Blk. 4, H. & G. N. Sur.	Spudded and temporarily abd.

BRISCOE COUNTY

C. S. Rice's No. 1 J. C. Anderson, SE cor. NW NW, Sec. 22, Blk. B-3, B. S. & F. Sur.	Fish., 1,600 ft.

CARSON COUNTY

Amatex Dev. Co.'s No. 1 E. S. Polling, Sec. 22, Blk. 2-Y.	Temp. abd., 1,980 ft.
Empire G. & F. Co.'s No. 1 C. R. Garner	Top pay, 3,100 ft; T.D., 3,140 ft; flowed 70 bbls. lime and granite wash, 3,120-40 ft; killing gas.
W. A. Gamble's No. 1-A John Dies, 30 ft N of cen., Lot 7, Blk. 11, Panhandle Townsite, Sec. 69, Blk. 2, T. T. R. R. Sur.	S.D., 1,045 ft. for casing.
Marland Oil Co.'s No. 1 Burnett-J. C NE NE Sec. 121, Blk. 5	Drlg., 3,165 ft; small spray oil 3,072-3,130 ft; salt water, 3,140-45 ft; dry granite wash, 3,245-88 ft.
Marston Oil Co.'s No. 1 J. L. Noel	Pulling 6-in., 3,064 ft.
Navajo Oil Co.'s No. 1 E. S. Polling, Sec. 22, Blk. 2-Y.	Setting 8-in., 2,150 ft.
Stubblefield et al's No. 1 E. Cooper, SW cor. NE Sec. 5, Blk. 9, I. & G. N. Sur.	Drlg., 1,400 ft.
Vitek Oil Co.'s No. 1 J. H. Eller, NE cor. NW Sec. 200, Blk. 3	Spudded and S.D.
Vitek Oil Co.'s No. 1 C. R. Garner, SW cor. Sec. 113, Blk. 4, I. & G. N. Sur.	Drlg., 2,840 ft; 15,000,000 ft. gas; first gas, 2,795 ft. and 3,070-80 ft; show oil, 3,040-45 ft.

CASTRO COUNTY

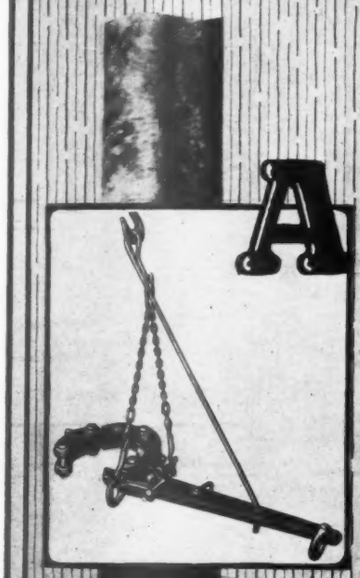
Colorado O. & R. Co.'s No. 1 M. Siemons, SW cor. Sec. 78, Blk. M-17, B. S. & F. Sur.	Rig.
Gulf Prod. Co.'s No. 1 Clements, SW cor. Sec. 27, Blk. M-10-A, Sealy & Morris Sur.	Top lime, 3,445 ft; set 6-in., 3,925 ft; drlg. hard brown gyp, 4,045 ft.
Mystery Oil Co.'s No. 1 J. I. Crum, SE cor. NE Sec. 333, Blk. M-6, S. K. & K. Sur.	S.D., 510 ft. for casing.

(Continued on Page 367)

(DUNN TOOLAGRAM)

Dunn Safety Casing Tongs now furnished with special short handles for use on ***make-and-break*** *rotary posts of other manufacturers, for making up casing.*

A New Wrinkle --by Dunn



Regarding this installation our field man reports—

"Previous to trying this tong they tried the ——— and two or three other makes, but these had all fallen down and they had trouble on account of most of them crushing the pipe.

The customer is well pleased with the performance of our tongs and will standardize on them for setting casing. They also have one 10″ Type "CX" Tong with the same style of handle. *They set 3800 feet of casing on this job and never looked back for anything.*"

If you want to try one of these tongs with a short handle, write or wire us. We'll send any type or size desired for trial, transportation charges prepaid, without the slightest obligation on your part. If it isn't the best tong you ever used for "setting," send it back, charges collect.

A type "RX" Dunn Safety Casing Tong equipped with a short handle for use in connection with an Oilwell make-up post for setting casing at Yount-Lee Oil Company's Fee No. 19, in the Spindletop field, Texas, where 3,800 feet of 7⅝" casing was set with the above pleasing results.

DUNN
MANUFACTURING COMPANY
OXNARD, CALIFORNIA

Mid-Continent Branch Warehouse 215 East Archer St. Tulsa, Oklahoma

Export Sales Office 150 Broadway, New York City

DUNN SAFETY means OIL WELL DUNN TOOLS DONE SAFELY

Seminole Peak Believed To Be Near

Much Depends Upon Future of Earlsboro. More Efficient Use of Air-Gas Lift in Bowlegs. Ample Pipe Line Facilities

By J. L. Dwyer
Staff Correspondent, Gulf Coast Fields

The Greater Seminole Field still occupies the stellar position in the Oklahoma fields, and with Seminole City continuing a gentle decline, there has been much interest evoked as to what may be expected of Bowlegs and Earlsboro.

Although it is admitted that three different conditions of oil production will be experienced in the three fields, it is thought likely that a certain similarity will be observed in the decline of all of them. Seminole City offered the best body of sand, and responded to the installation of the air-gas lift very well. Bowlegs wells have a very limited flowing life but make a good production when the lift system is installed. Owing to their limited flow, it is thought that probably the Seminole City Field has to some extent lowered the "head" of Bowlegs wells and that their only chance to make a good record lies in the possibility that engineering genius may devise some means of flowing the wells by artificial methods over a longer period than was possible in Seminole City. The industry has learned a great deal about artificial flowing of wells in the past three months, and certain interests are now conducting experiments with the air-gas lift. They are inclined to believe that in Bowlegs, the experiences of Seminole City will prove very helpful, and will enable them to flow the wells longer, and with a much lower column of oil than was possible at Seminole City.

Should this be true, it is likely that Bowlegs will sustain an output over 100,000 bbls. for several months, although it is the consensus of opinion that Bowlegs is very close to its peak production at present.

Unless the Earlsboro section of the field presents spectacular completions, it is probable that Greater Seminole is within 20,000 bbls. of its peak production right now. In this connection the uncertainty of Earlsboro should be considered, and one official of a company having large interests in the field recently made the remark that at Earlsboro, every third well would have a very small output. Past performances would seem to indicate that this theory is very reasonable, as the high and low features of the wells drilled thus far bear it out.

Earlsboro should touch its period of greatest output in about seven weeks if drilling continues at normal pace.

Operations Slowing Up

One significant feature observed last week is that a slowing up of operations has started. A comparison of the operations during the past two weeks is interesting:

	June 10	June 3
Locations	22	33
Rigs	46	52
Wells drilling	436	432
Total	504	517

This figure is lower than the total of 548 which was in evidence three weeks ago, and indicates that new work is not keeping pace with the completions. Formerly when a large well was completed, 30 or 40 new operations were announced, but the new work reported during the past three weeks has been confined in almost every instance to necessary wells. It is evidently the policy of the companies to delay all unnecessary work, as they have no inclination to develop expensive leases under the present crude price schedule.

Shut-Down Agreement Tightened

The Seminole shut-down is continuing to have its best results in limiting the output of outside wells, and during the past week an agreement was perfected among the royalty owners, and leaseholders around one new well which threatened, and which is believed to have very good possibilities. By reaching this agreement, the starting of 28 wells was prevented.

One of the disappointments of the past week was experienced in Amerada Petroleum Corp. and others' No. 1 Leah, NE cor. NW SE Section 24-8-4, within the boundaries of the Seminole agreement territory. This well, which had some production in the Hunton lime, found only a very small body of Wilcox sand which was touched 4,420-60 feet, with a hole full of water. It had been regarded as one of the wells which would have a bearing upon the future of the field, although the Wilcox was reported running low. The Hunton lime ran high in this test, and owing to the presence of many short term leases which were included in the block, it was deemed necessary to drill the well on down and test out the possibilities of the Wilcox.

Ample Pipe Line Facilities

The field now has pipe line accommodations for 400,000 bbls. of crude daily, and during the week two new pipe lines were placed in operation in the field. The Empire Pipe Line Co. completed a 10-inch line to connect with its system at the Cromwell Field, and the Pure Pipe Line Co. extended its 6-inch line from the Beggs station to Seminole, making it possible for the Pure to pipe line its own production from the field to its refinery at Muskogee, Okla. The present pipe line outlet of the field is as follows:

Company—	Daily Capacity (Bbls.)
Mid-Continent Petroleum Corp.	18,000
Barnsdall Oil Co.	5,000
Consolidated Pipe Line Co.	4,000
Empire Pipe Line	55,000
Gulf Pipe Line	32,000
Independent Pipe Line	5,000
Magnolia Pipe Line Co.	30,000
Oklahoma Pipe Line	90,000
Ozark Pipe Line	30,000
Prairie Pipe Line	50,000
Pure Pipe Line	12,000
Shaffer Pipe Line	4,000
Sinclair Pipe Line	50,000
The Texas Pipe Line	15,000
Tidal Pipe Line	5,000
Total	405,000

The present pipe line shipments out of the field are averaging about 300,000 bbls. daily and in addition to this about 30,000 bbls. daily are being shipped out of the field in tank cars. The remainder of the output is being placed in field storage.

The Seminole crude market continues to be very tight, and little oil is being offered over and above the current pipe line runs. The construction of large steel storage tanks has slowed up, as it is thought that present pipe line facilities are ample to eliminate any possibility of congestion in this area.

Seminole Production

The daily average production of the Greater Seminole Field by companies and leases for the week ending June 10 is given below:

Bowlegs Pool

Company and Lease—	Wells	Prod.
Amerada Petroleum Corp.:		
Rasco	8	10,115
Atlantic Oil Producing Co.:		
Jones	2	1,008
Baker	2	4,878
Fleet	2	4,425
Barnsdall Oil Co.:		
Murrow	1	242
McNac	1	Off
Carter Oil Co.:		
Bowlegs	2	5,125
Harjoche	4	5,595
Walker	1	3,076
Wise	4	5,815
Empire Gas & Fuel Co.:		
Lacey	4	6,644
Gypsy Oil Co.:		
Brown	1	197
Walker	5	4,280
Independent Oil & Gas Co.-Marland Oil Co.:		
Coker	1	650
Indian Terr. Illum. Oil Co.:		
Davis	2	3,492
Goforth	8	10,229
Livingston	8	14,294
Walker	6	7,943
Wilmont	3	3,810
Youngblood	2	3,578
McCulloch Oil Co. et al:		
Bowlegs	1	Off
Mid-Continent Petroleum Corp.:		
Baker	2	1,511
Hutke	1	80
Minnehoma Oil Co.:		
Bowlegs	1	2,226
Prairie Oil & Gas Co.:		
Gahagan	1	2,746
Harber	3	5,075
Whitney	2	746
Pure Oil Co.:		
Reed	9	10,721
Roxana Petroleum Corp.:		
Taylor	4	814
Sinclair Oil & Gas Co.:		
Adams	1	50
Bowlegs	1	436
Ellen*	1	1,755
Harjo	3	4,475
Jones	1	2,185
Taylor	1	2,505
Walker	2	2,280
The Texas Company:		
Reed	2	5,855
Tidal-Osage Oil Co.:		
Harjoche	1	1,650
Total	104	140,152

Earlsboro Pool

Amerada Petroleum Corp.:		
Anderson	3	6,515
Cowden	1	5,330
Barnsdall Oil Co.:		
Savolka	1	4,559
Smith	1	879
Peter	1	438
Crosbie et al:		
Bryant	1	3,275
Gypsy Oil Co.:		
Bora	1	Off
Earl	1	Off
McFarland	2	1,177
Peter	2	3,192
State land†	4	5,835
Strain	1	Off
Independent-Darby:		
Knappenberger	1	2,968
Interocean Oil Co.:		
Payne	1	Off
Magnolia Petroleum Co.:		
Bryant	2	6,772
Holmsley	1	6,644
Sparks	2	7,891
Mid-Continent Petroleum Corp.:		
McCumber	2	3,810
Phillips Petroleum Co.:		
Graham	3	2,377
Philmack-Marland:		
Dobbs	2	877
Prairie Oil & Gas Co.:		
Baker	1	300
Sinclair Oil & Gas Co.:		
Foreman	1	Off
Shallow production	30	4,080
Total	65	66,020

Seminole City Pool

Amerada Petroleum Corp.:		
Fixico	4	1,659
Killingsworth	4	490
Rentie	4	1,495
Atlantic Oil Producing Co.:		
N. Cudjo	4	245
J. Cudjo	2	Off
Carter Oil Co.:		
B. Carter	2	215
J. Carter	4	80
F. Carter	3	585
R. Cudjo	3	1,855
W. Cudjo	1	595
Gilliland	1	1,055
Grisso	8	1,435
Knappenberger	3	1,395
M. Killingsworth	9	18,597
G. Killingsworth	3	1,800
Lukes	6	3,935
Simpson	2	510
Strothers	2	5,700
Vierson	4	1,185
Barnsdall Oil Co.:		
Carter	9	5,142
Jones	4	2,054
Empire Gas & Fuel Co.:		
Gross	2	840
Wilson	3	1,326
Gypsy Oil Co.:		
Butler	3	1,147
Carter	8	2,422
Fixico	5	200
Harjo	2	1,005
Wolf	6	1,435
Cudjo	2	195
Independent Oil & Gas Co.:		
P. Fixico	1	345

ELEVEN COMPLETIONS IN MEXICO, FOUR PRODUCING 3,450 BARRELS

By George Blardone
Staff Correspondent, Mexican Fields

TAMPICO, Mexico, June 10.—The past week in Mexican fields was comparatively dull in so far as completions were concerned. Of the 11 wells completed, all of which were in the northern fields, only four finished in the production column, the remainder being failures. The new production secured totaled 3,450 bbls.

The best completion was Mexican Petroleum Co.'s No. 133 La Dicha, Ebano sector, which is rated 2,000 bbls. at 1,985 feet. National Lines' No. 71 Conteca, same sector, is good for 1,000 bbls. at 2,450 feet. Mexican Sinclair Petroleum Corp.'s No. 209, Lot 3 Cacalilao, is rated 50 bbls. at 1,925 feet; its No. 212, same, is rated 400 bbls. at 1,750 feet.

The failures follow: International Petroleum Co.'s No. 312, Lot 8 Cacalilao, is dry at 2,250 feet. Mexican Sinclair Petroleum Corp.'s No. 18 W. Maguabes, Panuco, is dry at 1,976 feet. La Corona Petroleum Co.'s No. 35, Lot 6 Corcovado, is dry at 2,667 feet. Cia. Pet. Franco Espanola (Marland) scored two dusters in Limon, Nos. 52-A and 98 finishing at 2,400 and 2,460 feet, respectively. Mexican Sinclair Petroleum Co.'s No. 35 is dry at 2,700 feet; and its No. 68 Midway drilled into salt water at 2,200 feet.

Panuco-Cacalilao

Drilling operations in the Panuco-Cacalilao sectors of the northern field have slowed down considerably as operators turn their attention to the Salinas and its juxtaposed sectors in the northern fields. In fact a good many unfinished holes in Panuco sector are standing shut down for the time being, smaller companies considered. As the week ended the active operations in the two sectors under discussion are best reflected as follows: Drillers' Percentage Association's No. 2 E. Maguabes is in gray lime at 1,820 feet. International Petroleum Co.'s Nos. 310 and 311, Lot 8 Cacalilao, are in gray lime at 2,080 and 2,191 feet, respectively; and No. 314, same, is also in gray lime at 1,590 feet. Mexican Sinclair Petroleum Corp.'s No. 154, Lot 1 Cacalilao, is in blue shale at 560 feet; No. 124-A, Lot 2, has cemented 8-inch in blue lime at 1,201 feet; No. 214, Lot 2, is in gray shale at 1,060 feet; No. 218, Lot 2, is in a similar formation at 970 feet, and one other location in Lot 2 is rigging. Transcontinental Petroleum Co.'s No. 213, Lot 2 Cacalilao, is in gray shale at 1,075 feet; No. 284 is in gray lime at 1,645 feet; No. 287 is in gray lime at 2,165 feet, and its No. 71 Paciencia is in shale at 600 feet.

Ebano-Salinas

In the above sectors, Mexican Petroleum Co. has the following operations: No. 37 Ebano is in shells at 1,275 feet; No. 70 Midway is in gray lime at 1,600 feet; No. 139 La Dicha is in blue shale at 285 feet; No. 141 is in gray shale at 1,080 feet; No. 151 is in hard gray lime at 1,680 feet; No. 152 is in gray and green lime at 2,256 feet; No. 119 East Dicha is in gray lime at 1,298 feet; No. 132 is in a similar formation at 1,730 feet; No. 70 Chijol is in gray lime at 1,930 feet; No. 72 is in hard green limt at 1,720 feet; No. 3 Shepard is in gray lime at 1,950 feet; No. 6 is in brown lime at 2,205 feet; No. 36 Pedro is in gray lime at 2,070 feet; No. 1 Budde is in gray lime at 2,126 feet; No. 2 Budde is

(Continued on Page 341)

The present rate of crude oil production is in excess of 900,000,000 barrels per year

500,000,000 barrels of crude oil brought out of the ground in the next 12 months would be ample to produce all the gasoline and all the lubricating oil required for our needs

This amount of crude can easily be made to produce in excess of 350,000,000 barrels of good gasoline—more than our present requirements

Figuring 135,000,000 barrels of gasoline from skimming operations, the remaining 215,000,000 barrels of better gasoline can easily be produced from the remaining skimmed crude by The Cracking Process

This is true conservation This is the efficient yield toward which every effort should be directed

Universal Oil Products Company
Owner of the Dubbs Process
310 South Michigan Ave
Chicago, Illinois

Independent-Garland:		
T. Fixico	8	405
Independent and Inter-Ocean:		
Jones	4	844
Harjo	1	Off
Indian Territory Illuminating Oil Co.:		
Bowlegs	10	4,207
Goodin	4	755
Harjo	4	731
James	4	1,088
Marcy	1	Off
Reed	3	87
Kingwood Oil Co.-Roxana Petroleum Corp.:		
Johnson	5	2,608
Magnolia Petroleum Co.:		
Franks	3	1,812
Mid-Continent Petroleum Corp.:		
Rentie	9	2,065
Tayeche	7	505
Mid-Kansas Oil & Gas Co.:		
Pressley	1	Off
Johnson	1	803
Philmack-McCulloch:		
Butler	2	1,100
Phillips Petroleum Co.:		
Strothers	3	900
Prairie Oil & Gas Co.:		
Gross	5	735
Spencer	1	25
Strothers	8	2,365
Mason	1	903
Pure Oil Co.:		
Strothers	17	3,696
Strothers B	3	5,295
Roxana Petroleum Corp.:		
Harber	2	681
Lashley	2	244
Sinclair Oil & Gas Co.:		
Dicey	1	440
Carter	2	48
Cudjo A	6	1,530
Cudjo B	3	1,040
Fixico***	4	700
T. B. Slick:		
Born	1	Off
Cudjo	3	1,936
Franks	8	2,665
Giblet	1	2,042
Superior Oil Co.:		
Cudjo	4	2,496
The Texas Company:		
Mayhue	1	30
Tidal-Osage Oil Co.:		
Carter	5	2,850
Fixico	7	1,610
Harjo	7	170
Mahardy	5	1,160
Tayeche	2	2,445
Turman Oil Co.:		
Cudjo	4	1,235
Grisso	1	579
Jones	4	4,925
Total	295	118,671
Searight Pool		
Carter Oil Co.:		
Davis	5	9,425
Frazier	4	8,135
Kiker	1	40
Scott	1	40
Stewart	1	Off
Gypsy Oil Co.:		
Cudjo	1	630
Mid-Continent Pet. Corp.:		
Grayson	5	6,435
Saloche	1	35
Prairie Oil & Gas Co.:		
Cannon	1	10
Carter	1	25
Houck	1	15
Kincaid	8	5,100
Pure Oil Co.:		
Aldridge	2	973
Roxana Pet. Corp.:		
Strothers	1	214
Searight et al:		
Youngblood	2	Off
Sinclair Oil & Gas Co.:		
Polly	2	1,035
Prairie Oil & Gas Co.:		
Weimer	1	40
Twin State Oil Co.:		
Jennings	1	1,000
H. F. Wilcox Oil & Gas Co.:		
Chupco	2	2,818
Total	41	35,970
Grand total	505	360,813
By Sands		
Shallow	31	4,105
Hunton lime	55	8,100
Wilcox	419	348,608
Total	505	360,813

*Half Kingwood Oil Co. **Half Amerada. ***Half Transcontinental.

Creek County

Winemiller Oil & Gas Co.'s No. 1 Oakhurst townsite, Lot 35, Block 23, Section 6-18-12, is spudding. J. H. Wright has the rig up for No. 20 Tahkaney, NE cor. NW NE NW, Section 24-17-10. Misner and others' No. 5 Broadnax, SE cor. NW NW, Section 16-17-11, is spudding. Thompson & Black's No. 2 Broadnox, NE cor. SW SW NW, Section 16-17-11, is spudding. Pioneer Petroleum Co.'s No. 2 Lewis, NE cor. SE NW, Section 19-17-11, is drilling at 1,000 feet. Atlantic Oil Producing Co. and Phillips Petroleum Co. made location for No. 1 Abraham, NW cor. SW SE, Section 19-14-9.

Cumberland Oil Co.'s No. 4 Tiger, NE cor. SE SE, Section 13-17-10, was completed for 5,000,000 feet of gas in the Dutcher sand 2,374-2,414 feet. J. H. Wright's No. 19 Tahkaney, NE cor NW NW, Section 24-17-10, is producing 680 bbls. from the Dutcher sand 2,425-36 feet. Skelly Oil Co.'s No. 1 Yellowhead, SE cor. SW NW, Section 32-17-10, found the top of the Dutcher sand at 2,678 feet and drilled in to 2,685 feet where the well flowed 5,400 bbls. the first day. Farquar and others' No. 1, Oakhurst Townsite, Lot 8, Block 25, Section 6-18-12, had the Turkey Mountain sand 2,190-2,200 feet and made 40 bbls. Future Development Co. and others' No. 1 Newton, SE cor. NE SW NE, Section 2-16-11, made 40 bbls. from the Wilcox sand 2,662-75 feet after it was shot with 10 and 20 quarts. No. 1 Jones, SW cor. NE NE, Section 2-16-11, had a hole full of water in the Wilcox sand 2,638-65 feet and has been abandoned. Mid-Continent Petroleum Co.'s No. 2 Friday, NE cor. NW SE, Section 31-15-9, made 15 bbls. after a shot of 140 quarts in the Layton sand 2,294-2,360 feet. No. 8 Walker, SE cor. SW NE, Section 32-14-10, was completed for 55 bbls. in the Dutcher sand 2,790-2832 feet.

Kay County

Blackwell Oil & Gas Co.'s No. 11 Nix, C N half SE, Section 18-28-1e, is being deepened, now drilling at 3,362 feet. H. A. G. Oil Co. is rigging up for No. 2 Binney, SE cor. SW, Section 21-27-1e. Carter & Failing's rig is on the ground for No. 2 Chambers, SW cor. NE SE, Section 9-25-2w, North of the Thomas Pool.

The Prairie Oil & Gas Co.'s No. 10 Smith "A," NE cor. S half SE, Section 1-26-2w, in the Hubbard Pool, had sand 3,872-91 feet and made 120 bbls. Marland Oil Co.'s No. 1-B Fitzgerald, SE cor. SW NE, Section 1-26-2w, had the Wilcox sand from 3,651 feet to 3,665 feet and produced 300 bbls. No. 2-B Fitzgerald, SW cor. NE, Section 1-26-2w, was completed in the Wilcox sand 3,540-3,601 feet the maximum production being 1,608 bbls. No. 4 North, Lease No. 1, SE cor NW NE, Section 12-26-2w, lost the hole at 2,602 feet and was abandoned. National Union Oil Co. and Marland Oil Co.'s No. 2 Glasgow, NW cor. SW NW, Section 6-26-1w, has been abandoned at 3,975 feet in the lime. Marland Oil Co.'s No. 1 Kaney, NW cor. SW NW, Section 7-26-1w, had a maximum production of 660 bbls. in the Wilcox sand 3,766-83 feet. No. 1 Chambers, NE cor. NW SE, Section 9-25-2w, north of the Thomas Pool, topped the Wilcox sand at 4,265 feet, drilled to 4,282 feet and produced 4,492 bbls.

Noble County

Mid Co Oil Co.'s No. 3 Brumfield, NE cor. NW NW, Section 22-23-2w, is dry at 2,716 feet.

Caddo County

English Drilling Co.'s No. 5 Abernathy, C SE SE, Section 31-6-9w, is pumping 60 bbls. daily from sand 2,374-83 feet.

Carter County

Atlantic Oil Producing Co. has built the rig for No. 4 Lyles, SW cor. NE NW, Section 11-2s-3w. Humble Oil & Refining Co.'s No. 14 W. S. Jordan, NE cor SW NW, Section 19-1s-3w, has a series of sands from 2,483 feet to 2,999 feet from which it is producing 185 bbls. after drilling to 3,312 feet and plugging back to 3,155 feet. Carter Oil Co.'s No. 4 Kimbrell, SE cor. NE SE, Section 21-2s-3w, is making 55 bbls. from sand 2,-247-60 feet. Iowa Oil Co.'s No. 1 Watkins was completed for 30 bbls. in a series of sands from 2,100 feet to 2,175 feet.

Comanche County

Abernathy and others' No. 2 Dockman, CWL NW NE, Section 32-4-10w, has been abandoned at 2,150 feet. Green and others' No. 1 Wilson C NE SW, Section 14-1-12w, is dry and abandoned at 2,300 feet.

Cotton County

Garvin & Urice's No. 1-A Fink, SE cor., Section 32-1s-10w, is dry and abandoned at 4,326 feet in the Arbuckle lime formation.

Grady County

Carter Oil Co. is cleaning out No. 1 Woods, SE cor. NE NE, Section 17-3-5w, in the Carter-Knox Pool preparatory to deepening below 1,929 feet the present depth. Gypsy Oil Co.'s No. 1 Hogue, NE cor., Section 20-3-5w, is being deepened, now drilling at 2,409 feet. Carter Oil Co. is rigging up rotary tools at No. 1 Finch, SW cor. NW SW, Section 22-3-5w.

Meridian Gas Co.'s No. 3 K. Farwell, NE cor. SE, Section 23-5-8w, has been abandoned at 3,170 feet. J. B. Nichols' No. 3 Reed, SE cor. NW NW, Section 25-5-8w, set the 8-inch casing at 2,160 feet, drilled to 2,360 feet and completed for 15,000,000 feet of gas. Berry and others' No. 2 Gardner, C SE SE, Section 3-4-8w, had sand 2,136-86 feet and is making 11,000,000 feet of gas. Carter Oil Co.'s No. 2 Dolen, NW cor. SE NW, Section 16-3-5w, is dry at 2,770 feet. No. 2 Eva Nation, SE cor. NE SE, Section 34-3-5w, is completed for 12,000,000 feet of gas from sand 2,279-82 feet.

Hughes County

McCullough Oil Co. made location for No. 1 Bruner, SW cor. NW SE, Section 16-9-9. T. B. Slick's No. 1 Anderson, NW cor. NE, Section 30-9-9, had a hole full of water in the Wilcox sand 4,248-4,420 feet and has been abandoned.

Jefferson County

Humble Oil & Refining Co.'s No. 1 Seay, SW cor. SE SE, Section 9-7s-5w, has been abandoned at 2,044 feet.

Okfuskee County

E. L. Robinson and others' No. 1-A Berryhill, NE cor. SW, Section 35-11-9, found water in the Papoose sand 3,151-60 feet and plugged back to the Gilcrease sand 2,898-2,925 feet and made 3,000,000 feet of gas. Champlin Oil & Refining Co.'s No. 3 Jacobs, SE cor., Section 15-11-11, topped the Wilcox sand at 3,477 feet and when drilled to 3,482 feet in the sand made 1,907 bbls. in 24 hours.

McIntosh County

John Aggas' No. 1 Perryman, CEL NW NW, Section 11-12-15, is drilling at 800 feet.

Pawnee County

Magnolia Petroleum Co.'s No. 5 H. Vogler, SE cor. NE, Section 32-20-6, is dry and abandoned at 3,510 feet. J. B. Grieves' No. 1 Bartlett, NE cor., Section 13-19-8 made 38 bbls. from sand 2,127-91 feet. Abicht Drilling Co. and others' No. 1 Zickfoose, NW cor. NE NE, Section 34-20-9, is dry and abandoned in the Layton sand 1,412-26 feet.

Payne County

Roxana Petroleum Co.'s No. 1 Scott, SW cor. NE NW, Section 31-17-4, after drilling to 4,563 feet, plugged back to sand 3,155-84 feet and made 200 bbls. after a shot of 60 quarts.

Tulsa County

Hivick and others have the rig up for No. 7 Walker, CSL N half NW SW, Section 16-18-13. Hall and others' No. 1 McKim, SE cor. NW, Section 33-18-13, is spudding.

S. W. Anthony's No. 2 Gilcrease, SW cor. SE NW, Section 34-17-12, has been abandoned in the Wilcox sand 2,420-32 feet. Savoy Oil Co.'s No. 1 Buck, NW cor SW SE, Section 7-16-14, had a hole full of water in the Wilcox sand 1,945-52 feet and was abandoned. No. 1 Bennett, SW cor NE, Section 8-16-14, made 30 bbls. after it was shot with 15 quarts in the Wilcox sand 1,950-56 feet.

Muskogee County

C. M. Bradley has a machine at the location for No. 6 E. Goodrich, SW cor. NW, Section 5-14-19. Denton & Marshall's No. 1 Taylor, NW cor. SW, Section 16-15-17, has been abandoned at 1,-550 feet in the lime. D. L. Howard's No. 1 Weaver, SE cor. NE SE, Section 18-13-19, is a dry hole at 1,000 feet.

Okmulgee County

Link Oil Co. has the rig on the ground for No. 1-A P. Bear, NW cor. NE SW, Section 22-16-13. T. E. Wheeler and others have the rig on the ground for No. 1 Raymond, SW cor. NW, Section 1-15-12. Briscoe and others have moved the rig out for No. 1 Briscoe, CNL SW SE, Section 26-15-12. The Texas Company's No. 3 Jones, CWL SW NW, Section 28-13-11, is drilling at 1,000 feet. Hammon & Devonian Oil Co. have built the rig for No. 1 Wisner, NE cor. NW SE, Section 5-15-13. Midland Oil Co.'s No. 1 Johnson, NW cor., Section 20-12-13, is spudding.

Hammon and others' No. 3 Lee, SW cor. SE SW, Section 26-15-12, is producing 2,000,000 feet of gas in the Dutcher sand 2,179-84 feet. A. E. Kirkland & Son's No. 4 Louiney, CWL NW SE, Section 17-15-13, was shot with 40 quarts in the salt sand 1,269-1,400 feet and produced 10 bbls. Sidwell Drilling Co.'s No. 3 Lunsford, NW cor. SW, Section 4-14-11, is dry and abandoned in the Wilcox sand 3,006-20 feet.

Osage County

Indian Territory Illuminating Oil Co. made location for No. 369 NE cor., Section 17-27-11. Location was made for No. 368 NE cor. SW, Section 22-27-11.

(Continued on Page 345)

SUMNER COUNTY WELL SHUT IN; ARKANSAS RIVER LITIGATION

By J. L. Dwyer
Staff Correspondent, Kansas Fields

The shut-down of the Churchill Pool of Sumner County, and the threat of legal proceedings against the state of Kansas by companies and individuals owning oil and gas leases on both sides of the Arkansas River in this part of the state were the chief bits of news gleaned from the past week's activities.

The Roxana Petroleum Corp. is reported to have another good well in Sumner County which will be shut in to await better price conditions. It is No. 1 Emrich, on the Oxford townsite in Section 13-32-2, and is estimated as being good for 800 bbls. daily from the Stalnaker sand touched at 2,014 feet. If this well were drilled in, it would very likely start another drilling campaign, and the Amerada Petroleum Corp., Barnsdall company and other concerns having lease holdings around the new well have consented to avoid drilling until better prices for crude are in evidence.

Advice from Wichita states that an effort is being made to have various lease owners having holdings adjoining the Arkansas River in the Churchill Pool institute proceedings against the state of Kansas for possession of the oil rights under the river. This would be a very interesting case if it crystalizes, as at one time a similar action was filed regarding oil producing lands in Oklahoma.

Butler County

Empire Gas & Fuel Co. made location for No. 1 Reitz, NW cor. SE Section 34-27-5. Blue Stem Oil Co. made location for No. 5 McLean, SW cor. NE SW Section 5-27-6. Phillips Petroleum Co. and others are building the rig for No. 4 Barnhill, NW cor. NE Section 23-27-7. Empire Gas & Fuel Co. has the rig on the ground for No. 1 Clark, NE cor. SE NE Section 3-28-5. Mid-Kansas Oil Co. made location for No. 1 McAffree, NE cor. NW NE Section 4-28-6.

Schwartz and others' No. 1 Hazlett, NW cor. SW SE NW Section 19-25-5, topped the sand at 712 feet and drilled to 723 feet and made 30 bbls. Rosenthal, Lassen and others' No. 5 Shaffer, SE cor. SW SE Section 4-27-6, had sand 3,144-52 feet and produced 300 bbls. Christy and others' No. 1 Harris, SW cor. SE Section 14-27-7, was shot with 160 quarts in sand at 2,672-2,716 feet and completed for 100 bbls. Morgan and others' No. 1 King, SE cor. NW NW Section 24-28-6, has a hole full of water in sand at 3,190-3,200 feet.

Cowley County

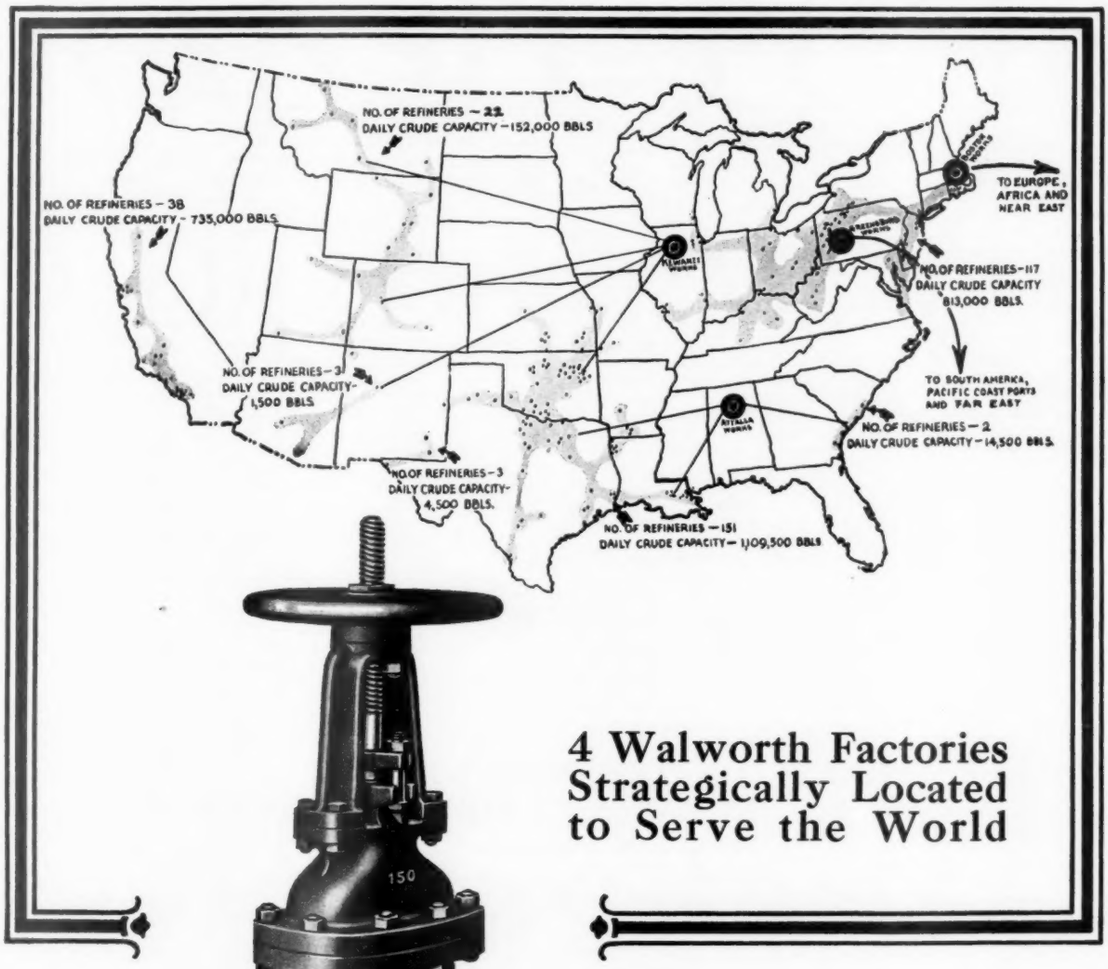
McNabb and others made location for No. 3 Wallace, SW cor. NE NW Section 22-32-4, Lot 5, in the Arkansas City Pool.

Twin State Oil Co.'s No. 3 Goodrich, NE cor. SW SE Section 21-31-4, was shot with 5 quarts in sand at 2,390-2,401 feet and made 45 bbls. Brinn and others' No. 1 Goodrich, SW cor. NE NE Section 33-31-4, is dry and abandoned at 3,471 feet. Roth & Faurot's No. 1 City of Winfield, SE cor. Lot 8, Block 45, was completed for 4,000,000 feet of gas in sand at 2,278-2,307 feet. No. 1 City of Winfield, Lot 3, Block 46, Section 22-32-4, made 100 bbls. from sand at 2,247-67 feet.

Dickinson County

Leeward Petroleum Co.'s No. 1 Jones,

(Continued on Page 351)


NO. OF REFINERIES – 22
DAILY CRUDE CAPACITY – 152,000 BBLS
NO. OF REFINERIES – 38
DAILY CRUDE CAPACITY – 735,000 BBLS
TO EUROPE, AFRICA AND NEAR EAST
NO. OF REFINERIES – 117
DAILY CRUDE CAPACITY 813,000 BBLS
TO SOUTH AMERICA, PACIFIC COAST PORTS AND FAR EAST
NO. OF REFINERIES – 3
DAILY CRUDE CAPACITY – 1,500 BBLS
NO. OF REFINERIES – 2
DAILY CRUDE CAPACITY – 14,500 BBLS
NO. OF REFINERIES – 3
DAILY CRUDE CAPACITY – 4,500 BBLS.
NO. OF REFINERIES – 151
DAILY CRUDE CAPACITY – 1,109,500 BBLS

4 Walworth Factories Strategically Located to Serve the World

Four Walworth plants, at Boston, Massachusetts, Greensburg, Pennsylvania, Kewanee, Illinois, and Attalla, Alabama, are ideally located for quick and efficient service to all parts of the world where oil is produced and refined. The tracks of some of the greatest railway systems in the United States lie alongside these four plants. On the map above the arrows indicate the easy accessibility of Walworth materials to users in the centers of oil production.

Have you sent for your copy of the Walworth Oil Catalog yet?

WALWORTH

Walworth Company, General Sales Offices: 51 East 42nd St., New York
Plants at Boston, Mass.; Kewanee, Ill.; Greensburg, Pa.; and Attalla, Ala.

. . . Distributors in Principal Cities of the World . . .

Walworth Limited, 10 Cathcart St., Montreal, P. Q.
Walworth International Co., New York, Foreign Representative

New Producing Spot in Mirando Area

Killam-Duggan No. 1 Cuellar, Zapata County, Tested 40,000,000 Feet of Gas With 600 Pounds Pressure

By B. D. Stevenson
Staff Correspondent, Southwest Texas Fields

SAN ANTONIO, Tex., June 13.—Killam-Duggan's No. 1 Cuellar in Zapata County, tested through drill stem at 1,359 feet for 40,000,000 feet of gas with a rock pressure of 600 pounds, is pointing to a new producing spot in the Mirando territory of the Laredo district. Last February Magnolia got a 4,000,000-foot gas well at 1,340 feet a half mile west of this well and about 3 miles east of the Jennings gas field. It was reported at the time as probably indicating some new production. The Killam-Duggan well is in the north quarter (surveys are diagonal with the world) of a 1,772-acre tract out of the north corner of the Cerrito Blanco Grant of Zapata County, and the well is 150 feet from the northwest and southwest lines of the quarter. It has not been completed but was tested through drill stem. The volume is so much greater that it indicates at least a gas pool that is worth while. The old Jennings gas field west of it has been supplying Laredo for many years from about six or seven wells and the volume in those wells is much reduced and is coming from a different sand. The Killam-Duggan well is a little less than 6 miles south and a little west of the Mirando Valley oil pool, where the discovery oil well of the district was drilled.

Other than this well it was a light week in all southwest Texas with a total of 10 completions, five being failures and three gas wells with total volume of 85,000,000 feet, and two oil wells, both in the Somerset Field, one making 18 and the other 9 bbls. on the pump.

Buys Gibson Lease

Golden West Oil Co. has bought the 50-acre Gibson Oil Corp. lease in the Ina Field in Medina County with four wells producing at about 950 feet. Golden West already had eight wells producing in the field. Golden West Oil Co., Magnolia Petroleum Co., The Texas Company and Arnett Oil Co. now own all the production in the Ina Field, with the Golden West possessing twice as many wells as any of the other companies. Price paid for the lease has not been made public. The field lacks pipe line facilities.

Mirando Completions
Zapata County

Killam-Duggan's No. 1 R. C. Cuellar, Cerrito Blanco Grant, east of the Jennings gas field, at 1,359 feet tested 40,000,000 feet of gas with rock pressure of 600 pounds through drill stem.

Duval County

Humble Oil & Refining Co.'s No. 12 Singer, Survey, 4 Palanga salt dome, abandoned dry at 3,659 feet.

Magnolia Petroleum Co.'s No. 2 R. Benavides, Survey 174, Block 7, O'Hern & Seacord Field, abandoned at 2,590 feet after testing salt water.

San Antonio Completions
Somerset Field—Bexar

N. A. Saigh's No. 3 Fress, Somerset Field, Bexar County, Sam McCullough headright, put on the pump at 1,369 feet and made 18 bbls.

Associated Petroleum Co.'s No. 3 Kohler, Survey 49, Somerset Field, completed on the pump making 9 bbls.

Medina County

Western Gas & Fuel Co. and C. E. Langes' No. 1 Chanler, located 1,000 feet east of Henderson & Holden's No. 1 Chandler in Survey 461, completed a gasser damp with gas at 986 feet and is estimated at 25,000,000 feet.

San Patricio County

W. L. Pearson's No. 1 Moore, Roos Survey, Block 3, has been abandoned dry at 2,600 feet.

Refugio County

Houston Gulf Gas Co. completed No. 6 Lambert at 1,165 feet at which depth it blew out and well has been turned into the lines without having casing set. Estimated production 20,000,000 feet.

Kleberg County

Carter-Walsh's No. 1 Flato, Lot 29, King land, has been abandoned dry at 3,034 feet.

Humble Oil & Refining Co.'s No. 3 Kleberg Trustee, Lot 1, Section 40, approximate depth 4,000 feet, has been abandoned dry.

NEW LOCATIONS
San Patricio County

J. M. Davis' No. 1 Welhausen & Driscoll, Subdivision 6 of the Taft ranch and in the exact center of Lot 8, Section 68, and 4 miles northeast of Gregory. Location has been made and contract let to George B. Pickett.

O'Hern & Seacord Pool

Magnolia Petroleum Co.'s No. 2 Benavides, Survey 174, Block 7, located 330 feet to northeast and northwest lines, has a sand at 2,590 feet and has set casing at 2,584 feet.

Cole Gas Field—Duval

Cole Petroleum Co.'s No. 38 Benavides, Survey 10, Block 12, located 155 feet to northeast and northwest lines, has derrick up; No. 45 Benavides, Survey 22, Block 2, located 450 feet to southwest and southeast lines, has been spudded in and is drilling at 1,000 feet. Houston Oil Co.-Sun Oil Co.'s No. A-4 Benavides, is location at corner of Blocks 405, 406, 411, 412. Houston Oil Co. Roxana's No. 1 Bruni, Survey 11, Block 18, is location 150 feet to northwest and northeast line.

Kitselman & St. Albans Field—Jim Hogg

Edward St. Albans' No. 8 Lopez, Share 1, Block 7, located 1,058 feet to south line and 974 feet to west line, is drilling at 1,600 feet. K. & S. Corp.'s No. 57 Holbien, Survey 17, Block 40, located 330 feet to NE cor., is fishing at 2,498 feet for collar and bit.

Fayette County

Magnolia Petroleum Co.'s No. 1, 9 miles northwest of La Grange, is setting up rig.

Alworth Field

Magnolia Petroleum Co.'s No. 22 Merchants State Bank, Survey 236, located 450 feet to west line and 150 feet to south line is drilling at 2,525 feet; No. 23 Merchants State Bank, Survey 415, located 1,070 feet to east line and 1,200 feet to north line, is moving on.

Albercas Gas Field

O. W. Killam's No. 2 Bruni, Block 65, located 1,470 feet to south line and 470 feet to east line is testing sand at 2,168 feet, No. 3 Bruni, Block 64, located 150 feet to north line and 450 feet to west line, is drilling at 3,212 feet.

Carolina-Texas Gas Field

D. J. Simmons No. 2 de la Garza, Survey 335, Block 8, located 150 feet to SW cor., is standing at 400 feet. Ward and others' No. 1 Webster, NW NE NW, Survey 684, located 150 feet to NW cor., is drilling at 2,600 feet. Houston Oil Co.'s No. 1 Barnsley, Survey 268, Block 9, located 150 feet to SW cor., is whipstocking out second time at 1,865 feet.

Aviator Field

Columbia Petroleum Co.'s No. 14 Puig, Block 77, is location.

Cole Gas Field

Cole Petroleum Co.'s No. 44 Benavides, Survey 411, Block 5, located 639 feet to north line and 682 feet to east line, at 2,322-39 feet tested gas with 735 pounds rock pressure; No. 46 Benavides, Survey 412, Block 5, located 1,032 feet to east line and 433 feet to south line, is moving on; No. 47 Benavides, Survey 412, Block 13, located 150 feet to east line and 450 feet to south line, has derrick up.

Rockdale Field—Milam

Yegua Oil Co.'s No. 1 Richards, J. H. Smith Survey, is rigged up and ready to spud in. Glass Brothers' No. 1 is location in vicinity if Hicks. Rockdale Development Co.'s No. 3 Lorenz, Thompson Survey, 300 feet east of No. B-2, has set casing to drill in. Groneman Brothers' No. 1 Key, Houston & Prewitt Surveys, is drilling at 500 feet. McCormick & Noack's (Wills Oil Co.) No. 1 Taylor Wooten, offset to No. 1 Rowland, is drilling. Noack Oil Co.'s No. 5 T. J. Chambers Survey, 300 feet southeast of No. 2, is drilling; No. 6 Seelke, located 300 feet southwest of No. 4, is moving in machinery. Coffield & Hale's No. 1 Shelton, located south of city limits of Rockdale, is ready to spud in. Fritz Fuchs' No. 3 Lon Hudson offsetting No. 4 J. B. R. Smith on the north, is drilling. Noack & Laning's No. 1 Dymke, William Allen Survey, NE cor., is standing; No. 1 Neely is location in southern extension and is nearly ready to spud in. Lowenstein Oil Co.'s No. 3 well is drilling in new location south of Rockdale. W. A. Jones' No. 1 Smith, T. J. Chambers Survey, located 150 feet to northeast lines and 810 feet to southeast lines, is wildcat test. Kent & Middleton's No. 1 Arnold is drilling in new section south of Rockdale. Noack & Laning's No. 2 Rowland, southern extension and offsetting No. 1, is ready to drill in.

Kingsville Field—Kleberg

Humble Oil & Refining Co.'s No. 4 R. J. Kleberg, Section 40, Block 6, located 660 feet to east line and 810 feet to south line, is location; No. 1 Gulf-Dennett, Section 38, Block 18, located 630 feet to west line and 150 feet to north line, is ready to spud in; No. 3 Kleberg trustee, Section 40, Block 1, located 150 feet to NW cor., at 3,866 feet is drilling with 16 feet of sand showing oil on the ether test; No. 1 Kleberg trustee, Section 40, Block 8, located 150 feet to NE cor., is drilling at 3,400 feet; No. 8-3 Dennett, NW cor., Block 2, Section 39, is drilling at 2,740 feet and using rock bit; No. 1 Kivlin NW cor., Block 5, Section 39, at 2,930 feet cored a hard sand with an oil sand above at 2,885-2,900 feet. Houston Oil Co.-A. C. Erwin's No. 1 Kivlin, Block 7, Section 50, located 660 feet to SE cor., at 1,730 feet is reaming. Carter-Welsh's No. 1 Flato, King land, Block 29, is drilling at 2,100 feet with 3,000,000 feet of gas at 1,887 feet.

Adams Gas Field—Medina

Witherspoon Oil Co.'s No. 2 Nixon, Survey 119, located 2,120 feet south of No. 1, is trying to mud off with barite at 940 feet. Western Gas & Fuel Co.-Witherspoon Oil Co.'s No. 3 Adams, Block 7, is location 631 feet west of No. 1 Adams of C. E. Lange. Witherspoon Oil Co.'s No. 1 Bader, Survey 135, lo-

(Continued on Page 341)

SUCCEED IN LOOSENING TOOLS IN MAVERICK COUNTY WILDCAT

By B. D. Stevenson

SAN ANTONIO, Tex., June 13.—Rycade Oil Corp. has succeeded in loosening the tools lost in the bottom of No. 1 Chittim in Maverick County, total depth 5,590 feet, that gauged 29,000,000 feet of gas and an estimated 100 bbls. of high gravity oil with the tools in the hole, and it is expected with but little doubt that the hole will soon be clear. Importance of the well is in the fact that it is not only 100 miles from any proven field but is producing from the Glenrose, a member of the Trinity group, being the first ever to produce from that formation in such volume in all the Balcones fault zone of some 350 miles. Coincident with this find in the Trinity, 17 miles from the Rio Grande River at Eagle Pass is the 12,000,000 feet of gas at 5,730 feet in the Steubenrauch well 3 miles west of Mexia also from the Trinity, and 350 miles away. The gas from this Mexia well will discolor a handkerchief. It is reported that Rycade will move in more rigs to Maverick County but this has not been confirmed. Almost at the same time that it succeeded in loosening the tools in the Chittim test it succeeded in getting the collapsed casing out of No. 1 Sullivan, which is 4 miles northwest and has set 9-inch casing at 3,832 feet.

The usual summer hot weather lull, along with the present low price of crude, is depressing the wildcat industry to some extent in this Southwest Texas area. However, the Magnolia is setting up rig on a wildcat test in Fayette County, 9 miles northwest of LaGrange. Yegua Oil Co. is starting a deep test 6 miles south of Rockdale in Milam County. Negotiations are under way for a 4,000-foot test in the Ina Field in Medina County. J. G. Pundt and B. F. Thompson have each started a deep test in Zavala County. W. S. Pool is moving in machinery for a test in Bee County, and J. M. Davis has made location and will move in at once on a deep test in San Patricio County, north of the White Point gas field and south of the Refugio gas field.

LAREDO DISTRICT
Brooks County

The Texas Company's No. 2 Lasater, Survey 329, is location 2,750 feet to north line and 150 feet to east line.

Duval County

Schlessinger Oil Co.'s No. 2 Hahl, Survey 60, is location 330 feet to north line and 1,650 feet to east line. National Oil Co.'s No. 1 Ball, Ball ranch, Survey 16, located 450 feet to north line and 150 feet to east line, has derrick up. George B. Pickett is making location in 3,000-acre lease of Ball ranch in northwest corner for No. 1 Ball. Ralston M. Talbott's No. 1 Margarite, Survey 4, located 2,500 feet to northwest lines and 1,320 feet to northeast lines, is standing at 1,600 feet. Humble Oil & Refining Co.'s No. 12 Singer, Survey 4, located 2,500 feet to north line and 2,000 feet to west line, is drilling at 3,659 feet; No. 2 Welder-Woods, Survey 102, located 5,280 feet to south line and 4,500 feet to east line, is drilling at 1,595 feet. Humble-Reiter-Foster's No. 6 Kohler, Survey 400, located 60 feet to west line and 660 feet to south line, is drilling at 878 feet. Dixie Oil-Southern Crude's No. 1 Gray, Survey 316, located 330 feet to NE cor., is having trouble at 2,460 feet to get water.

Hidalgo County

Queen City Oil & Gas Co.'s No. 1 Irrigation Co., Lot 1, Block 82, Capisallo district, is location.

Jim Hogg County

Holden and others' No. 3 Jones, Share 27, Block 136, located 330 feet to east line and 440 feet to north line, is standing at 1,471 feet, corrected depth. Harry Hamilton and others' No. 1 Holbien, Block 44, located 158 feet to south line

(Continued on Page 337)

TRANSIT PUMPS

and

One Other Make

Just two kinds

He was a salesman for ———— steam pumps, and he called on one of the big users, a nationally known oil company.

He told us that the man said to him:

> "I'm sorry Mr. Smith, but we have tried your pumps, also various others, and we now buy just two kinds—'TRANSIT PUMPS and one other make.'"

We thanked Mr. Smith for the high compliment he paid TRANSIT PUMPS, in telling us this experience.

Representatives

FRICK-REID SUPPLY COMPANY
Tulsa, Okla., or any store.

ASSOCIATED SUPPLY COMPANY
Los Angeles, San Francisco, Bakersfield, Fellows

E. L. WILSON HARDWARE CO.
Beaumont, Texas.

NATIONAL TRANSIT
Pump & Machine Co.
Oil City Pa.

DISTRICT OFFICES
NEW YORK PHILADELPHIA PITTSBURGH
CLEVELAND HOUSTON TULSA DENVER

Representatives

THE GLOBE SUPPLY & MACHINERY CO
New Orleans, La.

F. C. RICHMOND MACHINERY CO.
Salt Lake City, Utah.

MORTON McI. DUKEHART & CO.
Baltimore, Md.

REEVES & SKINNER MACHINERY CO.
St. Louis, Mo.

New Wildcat Play in Arkansas Area

Five Miles East of El Dorado East Field and Eight Miles North of Lawson-Urbana District

By Neil Williams
Staff Correspondent, Louisiana-Arkansas

SHREVEPORT, La., June 13.—That the center of oil play in the North Louisiana-Arkansas district might shift to an entirely new wildcat area seemed likely the latter part of the week following developments in Ohio Oil Co.'s No. 1 Crain, Section 1-17-14, Union County, Arkansas. This well, which is 5 miles east of the El Dorado east field (Galion) and about 8 miles north of the Lawson-Urbana district, has excited considerable interest, particularly among Arkansas operators, because of possibilities of it making a good pumper, if not a flowing well, in rank wildcat territory.

In a deep sand at a total depth of 3,014 feet, with 4¾-inch casing cemented at 3,009 feet, this test by bailing and swabbing made a head, which in 30 minutes poured 24 bbls. of oil into a 100-bbl. storage tank. When this stopped flowing, the bailer was run in at various depths and it was learned that the hole was standing 500 feet in water and 2,000 feet in oil, the latter testing 35.3 gravity.

The bailer was run again Saturday in an effort to make the well flow. A head was made, but low hanging gas caught fire from the boiler, doing considerable damage before being extinguished. The derrick, being steel, was uninjured. If the well will not flow, the Ohio is expecting to put it on the beam for a good pumper.

The oil apparently is coming from the same sand from which a deep well was completed in the El Dorado east field and from which Rovenger Oil Corp.'s No. 1 McCain, Section 4-17-16, and Walber & Phillips' Cordell No. 1, Section 6-18-13, found pay. This sand usually shows up well at first, but wells in it are comparatively short-lived, stopping their flow entirely or else turning to salt water. It has not been established yet that the Ohio well is in this sand.

The Rovenger Oil Corp.'s No. 1 McCain well in Section 4-17-14, which was completed a week ago and which now is pumping around 15 bbls. daily, is somewhat west of the Ohio well and in more or less semiwildcat territory just east of the El Dorado east field. The sand in that well is considerably higher, running at 2,834 feet.

Whether these wells mark long extensions to the east field in this deeper formation or whether an entirely separate pool has been found remains to be seen, but since the favorable developments in the Ohio well leasing has been fairly brisk on the part of the Ohio Oil Co. and the Dovenger Oil Corp. and several others. However, larger companies as a rule have manifested very little desire to enter the district, but the Sun Oil Co. has purchased several tracts, paying from $15 to $25 an acre, about a mile from the well.

These wells are far to the north of the Lawson-Urbana district in Township 18-Range 13, which for a time was watched by operators as a likely looking field for development. This area turned out several big gas wells and a few small oil showings, but now only one of these formerly big gassers is producing in commercial quantities, the others having gone to salt water. Another well, Sun Oil Co.'s No. 1 Thompson, Section 10-18-13, has just been completed, however, making 20,000,000 feet of dry gas at 2,657 feet.

The Arkansas discoveries have turned the attention of operators from the new Pleasant Hill Field of northern Sabine Parish, Louisiana, with little of importance developing there the past week. Louisiana Oil Refining Corp. so far has failed to make a flowing well of its No. 1 Logan, Section 28-10-12, which is northwest of the discovery wells. The hole is standing 1,800 feet in oil from a broken formation at 2,193-44 feet and 2½-inch tubing is being set with a packer in an effort to make it flow.

Unless this well flows, it is almost certain that the original theory of the majority of operators that what production there is will be to the southwest and on acreage held principally by the Arkansas Fuel Oil Co. It also has been fairly well determined that there will be nothing sensational about the field with the likelihood that all wells will be small producers.

Present indications point to the Arkansas Fuel Oil Co. getting a small well in No. 1 Rembert, Section 5-9-12. As the week closed, the liner in this well was being bailed with a showing of oil and gas. This well is at a total depth of 3,312 feet, with the top of the sand at 3,227 feet. This is an east offset to Moffett and associates' No. 1 Moore, which extended the field 1½ miles southwest when it came in making between 300 and 500 bbls. It now is flowing only around 75 bbls. daily. Total production of the Pleasant Hill Field is 675 bbls. daily from seven wells.

Arkansas Fuel Oil Co.'s No. 1 Moore, Section 32-10-12, is the next test due in and if it makes a producer it will mean an important extension, as it is nearly a half mile northwest of the Moffett well and 1½ miles southwest of the discovery wells. It is in a broken formation from 3,203 to 3,278 feet. As the week closed the liner had been set and the test swabbed down 500 feet from the top, showing a little oil.

Developments in the Arkansas-North Louisiana district as a whole were more or less routine, although from a completion standpoint 1,624 bbls. of new production was added to the daily production from 14 new wells. This was a good showing compared with previous weeks. Ouachita County, Arkansas, and Caddo Parish, Louisiana, accounted for most of this new production.

Production for the entire district reflected a loss of 370 bbls. in the daily average output, with a total daily average production during the week amounting to 160,115 bbls. Daily average production by fields for the week was:

NORTH LOUISIANA	
Caddo light	9,675
Caddo heavy	4,870
Homer	5,100
Haynesville	7,790
DeSoto and Red River	3,825
Elm Grove	720
Bellevue	1,350
Cotton Valley	5,750
Urania	8,610
Pleasant Hill	675
Total	48,365
ARKANSAS	
El Dorado	6,250
Lisbon	3,810
Smackover light	11,175
Smackover heavy	87,520
Stephens	1,400
Nevada	1,470
Bradley	125
Total	111,750
Total both states	160,115
Total last week	160,485
Decrease	370

Smackover operators have been having considerable difficulty in restoring production of that field to preflood levels, and it is possible that the high water, which forced a general shutdown, caused a permanent injury to the second sand in particular.

Two late completions of the week were J. J. O'Brien's No. 1 Moss, Section 1-14-21, Irma district of Nevada County, Arkansas, and B. A. Hardy's No. 1 Trosper, Section 35-18-16, Waskom Field of Caddo Parish, Louisiana. The former is pumping 150 bbls. daily from sand at 1,143-49 feet. Clark & Greason's No. 1 Grove, in this same district, Section 12, also is being placed on the pump, it having 600 feet of oil in the hole from sand at 1,148-52 feet.

The Waskom well was completed making 12,000,000 feet of gas from a depth of 898 feet. It is one of a series of gas wells being completed by Mr. Hardy to build up a 75,000,000-foot daily reserve.

Another late development is the abandoning of Ohio Oil Co.'s No. 1 McCarty, Section 5-12-1w, Winn Parish, Louisiana. This is the test which early in the week led operators to believe it had open gas possibilities in that district when it topped a gas rock at 2,556 feet. At a total depth of 2,572 feet in a sandy lime it tested dry.

Detailed Operations

Detailed operations in proved fields the past week were:

Bossier Parish

Humble Oil & Refining Co.'s No. 30 Bliss & Wetherbee, Section 15-19-11, deep Bellevue test, is drilling in sandy shale at 2,351 feet.

Caddo Parish

J. R. Bahan has abandoned as dry his No. 1 Abney, Section 9-17-16, Waskom Field. This test was down only 934 feet having been started just a week ago. In the same section another test was abandoned during the week, this being Owl Oil Co.'s No. 4 Florsheim, which had reached a total depth of 1,263 feet. The latter company also has abandoned a location made for No. 3 Wilburn in Section 4.

Arkansas Natural Gas Co. encountered a gas sand at 1,929 feet in No. 8 Gayle, Section 30-16-12. The flow was estimated at 500,000 feet. The test will be deepened. The same company has a rig up for a test in the Pine Island district, this being the No. 2 Lane, Section 13-21-15. Askew and associates are drilling at 2,400 feet in No. 1 Elliott, Section 12-19-16. Bayou State Oil Corp. has completed No. 29 Hoss, Section 24-22-15, pumping 15 bbls. at a depth of 1,054 feet. This company also has a derrick up in the same section for No. 30 Hoss. J. W. Burton is arranging to abandon No. 16 Bunker & Tompkins, Section 18-21-15. It tested salt water at a depth of 1,056 feet. In Section 33-21-16, W. D. Chew has completed No. 6 fee pumping 60 bbls. daily from a depth of 1,850 feet.

Dixie Oil Co. is drilling at 2,035 feet in No. B-5 Files & Mabry, Section 14-21-16, and at 2,540 feet in No. 8 Fitzsimmons, same section. In Section 13-21-15, this company's No. A-2 Noel is drilling at 3,850 feet. The 6-inch casing had been reset at 3,842 feet. No. 88 Robertshaw, also this section, is being bailed for a test at a depth of 1,740 feet. No. 10 Slattery in Section 27 is being standardized at 3,877 feet. Dobson and associates have cemented 6-inch casing at 1,850 feet in No. 5 Rives, Section 5-20-16. Empire Gas & Fuel Co. has abandoned as dry at 1,665 feet No. B-1 Levee Board, Section 31-21-16. Falcon Drilling Co. is down 1,412 feet in No. 1 Schmidt, Section 27-20-15. Ten-inch surface casing was cemented at 42 feet. In Section 14, Gulf Refining Co.'s No. 5 Wemple has been completed at 2,214 feet pumping 150 bbls. This company's No. 269 Ferry Lake, Section 29-20-16, is being bailed for a test at a depth of 2,325 feet. No. 13 Tyson, Section 14-21-15, is drilling at 3,695 feet.

Starts Operations

B. A. Hardy has started operations at No. 2 Angurs, Section 6-16-16, and is down 300 feet, cemented 10-inch casing at 195 feet. He has a rig up for No. 1 Hammock, Section 27-18-15. He has cemented 8-inch casing at 876 feet in No. 1 Trosper, Section 35-18-16. In No. 1 Wheeler, Section 18-18-16, he is drilling at 100 feet. Haynes Brothers are drilling the plug at 3,952 feet in No. 1 Murray, Section 14-21-15. In Section 22, Lewis Oil Corp. is drilling at 1,270 feet in No.

25 OUT OF 46 WELLS SHUT DOWN IN SOUTHEASTERN NEW MEXICO

Special Correspondent

ARTESIA, N. Mex., June 11.—Twenty-one drilling wells were active and 25 shut down in southeastern New Mexico in the past week in review. There were two completions, Wooley-Jones' No. 1 permit, SE cor. Section 33-17s-30e, Eddy County, hole full of water and abandoned at 3,505 feet, and Gilmore & Sheldon's No. 1 Tome, NE cor. Section 30-6n-3e, Valencia County, abandoned at 610 feet. The Skelly Oil Co.'s No. 1 permit, C SW, Section 21-17s-30e, is still flowing by heads and making over 100 bbls. a day. The depth of the well, corrected measurement, is 3,811 feet.

In Chaves County, Sparrow & Drake have moved over 150 feet and will drill a new well in the SE cor. SW, Section 11-6s-27e, Chaves County. They lost the hole in the first attempt. The Texas Production Co. is shut down at 3,645 feet, awaiting a new drilling cable, on No. 1 Dunken Dome, Section 29-17s-18e.

In Eddy County, the Texas Production Co.'s No. 1 permit, NE cor. SW, Section 25-16s-25e, was working with 10-inch pipe at a total depth of 2,450 feet. Empire Gas & Fuel Co.'s No. 1-B permit, Section 34-17s-27e, was drilling in lime at 2,340 feet. The Midwest Refining Co. was drilling with a hole full of water at 865 feet in No. 1 Terry, SW cor. Section 15-18s-26e. Flynn, Welsh & Yates' No. 4 Dunn, SE cor. SW, Section 10-18s-28e, was drilling at 2,215 feet. George Getty was spudding No. 1 permit, SE cor. SW, Section 14-20-29e. Marland Oil Co.'s No. 1 permit, CWL, Section 11-20s-30e, set 8¼-inch pipe at 2,480 feet, got a hole full of water at 2,500-10 feet, and was drilling at 2,530 feet. The Superior Oil Co.'s No. 1 Keck, SW cor. NW, Section 33-23s-28e, set pipe at 877 feet.

In Lea County, Leonard Levers drilled to 4,005 feet, but will go deeper, in No. 1 State, SE cor. SW, Section 11-16s-32e. Inglefield-Bridges are swabbing and cleaning out preparatory to deepening No. 1 State, SE cor. Section 4-17s-34e. It is now at a total depth of 4,840 feet. The Exploration Co.'s No. 1 patent, C NE, Section 25-19s-35e, was drilling at 2,833 feet. The Texas Production Co.'s No. 1 Rhodes, NW cor. Section 22-26s-37e, was fishing at 3,040 feet.

In northeastern New Mexico only three wells showed any activity. In Colfax County, W. D. Weathers and others were drilling below 1,015 feet in No. 1 permit, C Section 7-29n-24e. In Quay County, the Midwest Refining Co. was drilling below 3,400 feet in No. 1 Wilson, SW cor. NW, Section 30-8n-31e. In Union County, the Sun State Oil Co.'s No. 1 Pasa Monte, Section 14-24n-30e, was drilling below 2,806 feet.

18 Raines. Luby Oil Co. has completed No. 15 Levee Board, Section 23-22-15, pumping 12 bbls. from a depth of 1,047 feet. This company has cemented the 6-inch casing at 1,000 feet in No. 16 Levee Board, also this section. Magnolia Petroleum Co. is arranging to drill the plug at 2,910 feet in No. 2 Caddo, Section 8-20-15. The same company is bailing No. 4 Caldwell, Section 24-21-15, to make a test at 1,620 feet. This company is drilling at 1,136 feet in No. 1 Bell, Section 4-17-16, Waskom Field. In Section 23-21-15 this company is bailing No. 20 Robertshaw to make a test at 3,659 feet. Marshall Natural Gas Co. is bailing No. 1 Sharp, Section 22-18-16. Total depth of this hole is 1,897 feet. In a previous attempt to bail this test the 8-inch casing collapsed at 1,300 feet. Ohio Oil Co. has abandoned temporarily No. 1 Aaron, Section 32-23-16. The hole is at a depth of 1,553 feet. In this section the Ohio Oil Co. is building a derrick for No. 1-E Plum. This company's No. 25 Smith, Section 12-21-15, is drilling at 3,180 feet. Shreveport Oil Corp. is arranging to take a test in No. 2 State, Section 27-21-15. Simplex Oil Co. is bailing for a test at 2,212 feet in No. 3 Thomas, Section 15-20-15.

Standard Oil Co. is waiting on a standard rig for No. 13 Hart, Section 34-21-16. Total depth is 1,823 feet. No. 14 Hart, this section, is drilling in chalk rock at 1,260 feet. A derrick has been completed for No. 185 Stiles, Section 33-21-16. In Section 27-18-16, The Texas Company has a derrick up for No. 1 Alexander. This company's No. B-13 Noel, Section 14-21-15 had a blow-out at 3,035 feet, making an estimated 10,000,000 feet of gas daily and lots of salt water. This test, however, soon bridged over. No. 7 Curtis, Section 14-20-15, has been completed pumping 140 bbls. from a depth of 2,213 feet. Tholl Oil Co. is arranging to deepen No. 11 Bashara, Section 23-21-15. It formerly was completed pumping 15 bbls. from a depth of 1,710 feet.

LaSalle Parish

Ayers Brothers have started operations in No. 5 Urania, Section 30-10-2e, Urania Field, and have set 10-inch casing at 100 feet. Louisiana Oil Refining Corp.'s No. B-1 Tremont, same section, is shut down waiting orders at a depth of 1,582 feet. Yeary & Bristol have abandoned No. 5 Urania, Section 8. Total depth is 1,552 feet.

Monroe District

Consolidated Carbon Co. has cemented 6-inch casing at 2,086 feet in No. 1 White, Section 16-20-4e, Morehouse Parish. Falcon Drilling Co. is down 580 feet in No. 1 Gladney, Section 5-21-7e. Natural Gas Products Co. has set 12½-inch casing at 185 feet in No. 20 Crossett, Section 21-23-7e. United Carbon Co. has completed No. 1 Townsend, Section 29-21-5e, making an estimated 6,000,000 feet of gas from a sand at 1,270 feet.

In Ouachita Parish, Consumers Gas Co.'s No. 1 Williams, Section 10-18-5e, is making an estimated 900,000 feet of gas from a sand at 2,270 feet. Jordon Drilling Co. also has a gas well estimated to be making 3,000,000 feet of gas from a sand at 2,238 feet. This is No. 2 Montgomery, Section 13-18-4e. Ladell Properties, Inc., is drilling at 1,919 feet in No. 40 fee, Section 29-20-5e. No. 41, Section 31-20-5e, is down 740 feet, the 12½-inch casing having been cemented at 180 feet. The Palmer Corp. has cemented 6-inch casing at 2,147 feet in No. 4 Millsaps, Section 25-19-2e.

C. E. Camette's No. 1 Tugwell, Section 21-22-1e, Union Parish is drilling at 1,580 feet.

Webster Parish

W. T. Hunt's No. 1 Bistenau, Section 35-18-10, is drilling rock at 375 feet. Louisiana Oil Refining Corp. has cemented 6-inch casing at 2,559 feet in No. 7 Gray, Section 28-21-10. Magnolia Petroleum Co.'s No. 3 Cox, Section 23, is drilling at 2,800 feet. This company's No. 1 Marshall, Section 21, is drilling out the plug cemented at 2,546 feet. No. 2 Marshall, this section, is drilling at 1,329 feet in a shale formation. Northwest Louisiana Gas Co. has cemented 4½-inch casing at 4,200 feet in No. 1 Coyle, Section 22. In the same section is another deep test, Ohio Oil Co.'s No. 4 Bank which is down 3,395 feet. At present 8⅝-inch casing is being run in. Woodley Petroleum Co. has cemented 12½-inch casing at 270 feet in No. B-1 Cox, Section 23-21-10.

Union County

In the Louann district of the Smackover Field, G. J. Childs is bailing No. B-2 fee, Section 8-16-16, to make a test of a sand at 2,260-68 feet. In Section 21, Magnolia Petroleum Co. has cemented 8¼-inch casing at 2,655 feet. It has a sand at 2,658 feet.

In the Norphlet area, J. J. O'Brien has a 2-bbl. pumping well in No. 1 Saxon, Section 16-16-16, which has been completed at a depth of 2,170 feet. Humble Oil & Refining Co. also has a well pumping 40 bbls. in No. 10 Pate, Section 10-16-15. This well has been completed at a depth of 2,383 feet. The same company's No. B-2 Flenniken, Section 9, has been abandoned temporarily at 2,776 feet. E. M. Jones is coring at 225 feet in No. 2-A Lawton, Section 10. Magnolia Petroleum Co.'s No. 9 Murphy, Section 8, is down 2,723 feet atfer drilling out the 6⅝-inch plug cemented at 2,718 feet. The same company's No. 6 Wilson, Section 17, tested salt water at 2,806 feet and is drilling in red beds at 2,830 feet. National Gas & Fuel Corp. has cemented 6⅝-inch casing at 2,388 feet in No. E-3 Murphy, Section 9. In No. F-5 the same company has milled out casing at 2,390 feet and is coring a broken formation at 2,402 feet. Also in this section is Ohio Oil Co.'s No. 5 Murphy deep test which is down 2,883 feet. The 4¾-inch casing is cemented at 2,686 feet. Sam Richardson's No. 5 Lawton, Section 10, has been plugged back to 2,720 feet. It tested salt water and a showing of gas at 2,739 feet. Southern Crude Oil Purchasing Co. has a fishing job in No. A-5 Wells, Section 15, having lost the cable tools at 2,640 feet.

Atlantic Oil Producing Co. has a rig up for No. 11 Dumas, Section 9-17-16, Lisbon district. Mountz and associates' No. 6 Pratt, Section 8-18-5, main El Dorado Field, is drilling at 2,110 feet.

Ouachita County

F. A. Book is coring at 2,245 feet in No. 3 Johnette, Section 33-15-16, Louann sector of Smackover field. The Texas Company is drilling at 100 feet in its new test, No. 1 Spahr, Section 35-15-16. Ten-inch casing was cemented at 58 feet. Exchange Oil has completed two good wells in the Norphlet area, one being No. 6 Behr, Section 4-16-15, pumping 200 bbls. from sand at 2,361-68 feet, and the other being No. 3 Umstead, same section, pumping 175 bbls. from sand at 2,357-64 feet. No. 3 Berg, also in this section, has been cemented back to 1,900 feet from a total depth of 2,352 feet. No. 7 Berg is drilling at 2,350 feet. Roxana Petroleum Corp. is milling on junk at 2,597 feet in No. 1 Reynolds, Section 27-15-15. Total depth is 2,612 feet. Sunny Jim Oil Co. has cemented a short string of 4½-inch casing at 2,359 feet in No. 12 Berry, Section 33-15-15. Magnolia Petroleum Co.'s No. 1 Morgan, Section 7-15-19, Stephens Field, is drilling sandy lime at 2,590 feet.

Nevada County

Ozan Oil Co. has completed No. 6 Ellis, Section 2-14-21, pumping 100 bbls. daily from sand at 1,154-62 feet. Fruen and associates have started a new test in Section 22-12-12. This is the No. 1 Rhodes, which already is down 1,025 feet. The 10-inch surface was cemented at 60 feet. J. J. O'Brien's No. 1 Moss, Section 1-14-21, is drilling the 6-inch plug cemented at 1,149 feet.

NEW WILDCAT AREAS INTEREST LOUISIANA-ARKANSAS OPERATORS

By Neil Williams

SHREVEPORT, La., June 13.—Developments of the past two weeks have turned the attention of North Louisiana and Arkansas operators to new wildcat areas, principal among which is that around the Ohio Oil Co.'s No. 1 Cain, Section 1-17-14, and Rovenger Oil Corp.'s No. 1 McClain, Section 4-17-14, both in Union County, Arkansas, considerably east of the El Dorado East Field.

Also in the Dolet Hills district of De Soto Parish, Louisiana, activity has been revived since the bringing in of Hoosier Oil Co.'s No. 1 Lanier, Section 5-11-11, which still is flowing at the rate of 180 bbls. daily of clean oil. This company already has another rig up and two locations staked.

Of interest in the Carterville area in northern Bossier Parish, Louisiana, is the abandonment of the attempt of W. R. Ramsey to make a deep test of No. 1 Robertson, Section 22-23-12. After passing up the gas sand in the district this test was drilled deeper to find the true Woodbine but after encountering red shale from 3,392-3,476 feet it is being plugged back to the gas sand at 3,099 feet. As a result of this, Ramsey's No. 1 Dodson, Section 16, will not be drilled beyond the gas sand.

In the latter test, the cap rock was encountered 5 feet higher than in any other wells in this territory and the well blew out before casing was set. Another string will be cemented inside the 8-inch which was cemented at 2,845 feet. Total depth is 3,077 feet.

Magnolia Petroleum Co.'s No. 1 Dodson, Section 15, has drilled out the plug cemented at 3,084 feet and bailed the casing dry and as the week closed was drilling in.

Palmer Corp.'s deep test, in Bossier Parish, the No. 4 Bossier L. & L. Co., Section 9-16-11, received a setback during the week when lightning struck the derrick causing 4,200 feet of drill stem to fall over and scatter. The derrick will have to be rebuilt and the drill pipe straightened. At the time, the test was waiting on cement to set, the 6-inch casing having been cemented at 4,150 feet.

Abandonments

Ohio Oil Co. has abandoned No. 1 McCarty, Section 5-12-1w, Winn Parish, this test having tested dry at 2,576 feet, but has staked a new location for No. 1 Rowland, this section. The Ohio Oil Co. also has abandoned No. 1 Thomas, Section 23-13-6w, Natchitoches Parish, which encountered rock salt at 2,450 feet. This is the company's second test on the Chestnut salt dome, and a location has been staked for a third, the No. 2 L. & A.

The play to salt domes in North Louisiana has been one of the important developments in wildcatting which has been reflected in the starting of numerous tests in parishes having these domes, particularly Bienville and Winn Parishes. During the week J. D. Houseman and associates completed working up an 8,000-acre block in the W half of Township 17-5w, south of the Arcadia Dome, Bienville Parish. Forrest and associates have a 6,500-acre block adjoining this in Township 17-6w, on which they will drill in the near future.

In Winn and Grant Parishes, Gulf Refining Co. has a torsion balance crew with two machines working Township 9-1e in an effort to locate salt domes. The crew apparently is centralizing its efforts in Section 8 but is including Sections 4, 5, 6, 7, 8, 9, 16 and 18. Some work also was done around the Cedar Creek Dome in Townships 10 and 11 and Range 2w.

Detailed wildcat operations during the week were:

NORTH LOUISIANA

Bienville Parish

W. E. Hicks and associates have started drilling in No. 1 Hodge Hunt, Sec-

(Continued on Page 341)

INLAND SALT DOMES PRESENT NEW PROBLEMS TO TEXAS OPERATORS

Special Correspondent

CORSICANA, Tex., June 11.—The Humble Oil & Refining Co.'s No. 1 Elliott in the Boggy Creek area in western Cherokee County, is still being worked over in the hope of making a paying producer out of it and at the same time of determining the source of the water that converted it from a big initial producer into a salt water well.

The hole was plugged back to 3,837 feet and while it was being cleaned out the bailer was hung up about 300 feet off bottom. The well makes occasional heads of from 1 to 15 bbls. without any show of water. At one time it gave promise of being good for over 5,000 bbls. a day.

Officials of the Humble company have said they still retain their confidence in the east central Texas salt dome area, but that inland salt domes present problems not usually found in the coastal domes and it will take time to solve these.

The Sun Oil Co. has abandoned its deep test on the Swink farm between Richland and Currie in Navarro County after a long fishing job to recover a section of 3-inch drill stem. This hole had reached a depth of 5,412 feet and next to the deep test of E. L. Smith and others near Mexia, Limestone County, was the deepest hole in the east central Texas territory. Smith and others' well is below 5,740 feet and has shown a strong gas pressure and some oil at 5,732 feet. While setting 6-inch casing in this hole the pipe collapsed at 1,500 feet from the top.

Nicolle & Wife have abandoned their No. 1 Hill, Dusk Survey, in Cherokee County after a hopeless fishing job. The Humble Oil & Refining Co.'s No. 2 Earl & Ragsdale, Johnson Survey, was drilling below 4,215 feet and the same company's No. 1 Reynolds Mortgage Co., Isaac Durst Survey, was drilling below 3,500 feet.

The Kechi Petroleum Co.'s No. 5 Pickens, Prewitt Survey, Freestone County, which had been shut down a long time, has been abandoned, total depth 4,276 feet.

The Magnolia Petroleum Co.'s No. 1 Marshall, Chambers Survey, Navarro County, had a showing in a core taken at 4,354 feet. It was reported that pipe would be set and this sand given a test.

In Anderson County the Humble Oil & Refining Co.'s No. 2-A Southern Pine Lumber Co., Merton Survey, was drilling at a total depth of 4,419 feet in sand and shale.

In Hunt County, the Amerada Petroleum Corp.'s No. 1 Walter Grainer, Hamilton Survey, set pipe at 3,177 feet. There was a showing of oil in sandy shale from 3,111 to 3,149 feet.

Cranfill Brothers were drilling below 2,725 feet in No. 1 Nicholson, Bennett Survey, Austin chalk being penetrated at 2,300-2,672 feet.

GLYCERIN BLOWUP KILLS TWO

BUTLER, Pa., June 10.—Two oil well workers were killed instantly and 20 other persons were injured, two seriously, when 400 quarts of nitroglycerin, being hauled in an auto truck to a storage magazine, exploded on the main highway at Lick Hill, near here.

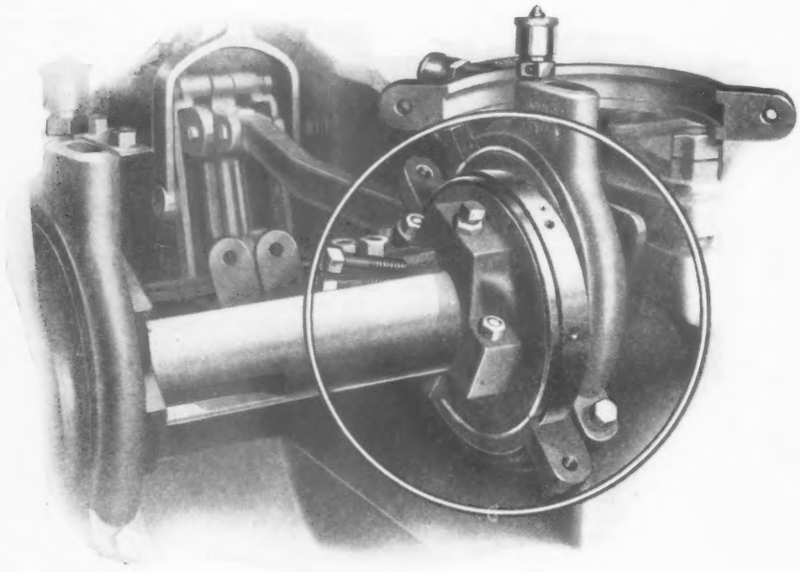
The dead: Frank K. Greer, driver of the truck, and Victor Coxan, his helper, both of Oil City.

The terrific blast destroyed three houses and damaged several others in the village of Lick Hill.

Mrs. Edward Redeig and her daughter, Margaret, among the six more seriously injured, in a hospital here, are not expected to live.

The explosion occurred when a rear wheel of the truck slipped from the concrete highway into a small ditch as the machine was turning into a mud road.

Two Improvements for Ideal-Ajax D



Photograph shows how the new bronze bushing fits between eccentric hub and strap. It has oil holes for lubrication.

New Bronze Bushed Eccentric Straps

Split Bronze Bushing placed between Eccentric Strap and Hub, takes all wear, easily replaced.

Bushing made of best bearing bronze, eccentric straps made of malleable iron.

Can be quickly attached to eccentric hubs not equipped with this feature.

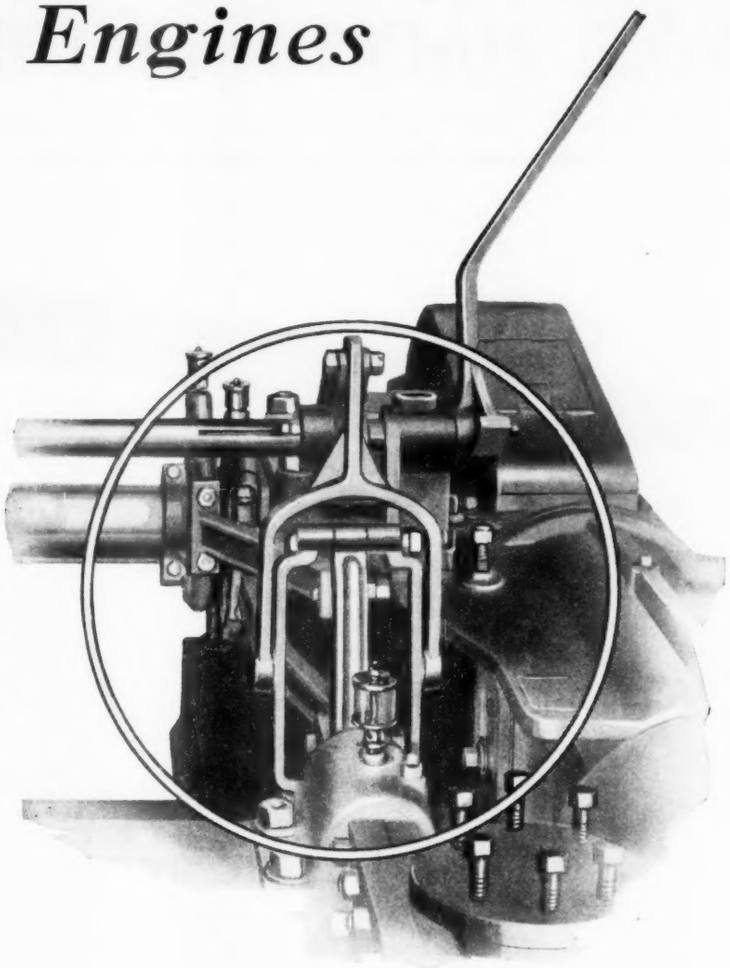
Holes in Bushing and Groove in Strap provide ample lubrication.

Made by
AJAX IRON WORKS
Corry, Pa.

AJAX-
DRILLING

Drilling Engines

AJAX ENGINES

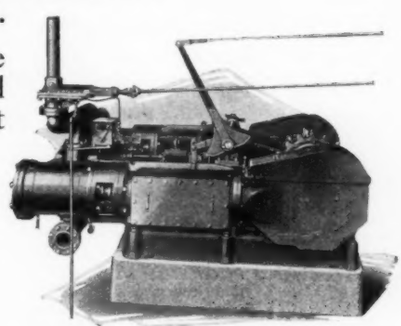


Photograph of new Ajax reverse link lifter. Ajax was the first to use the link reverse and the first to use hardened and ground link roller.

New Reversing Link Lifter

Easier to reverse, less wear on reversing parts. Lifter Yoke attached to side Brackets lifting link from center instead of top, cuts down the motion required to reverse and eliminates vibration of reversing parts.

Yoke and Bracket made of cast steel, bronze bushings in yoke, hardened and ground Bracket Pins, Drake Lock Nuts on Bracket to Link Bolts.



DISTRIBUTED BY
THE NATIONAL SUPPLY COMPANIES
NSCO

In every oil field

STEAM ENGINES

CONGRATULATING

Captain Charles Lindbergh

on his heroic achievement

Bethlehem Alloy Steel Forgings used in Lindbergh's Engine

The following parts, made of Bethlehem Alloy Steel Drop Forgings, stood the test with Captain Lindbergh:

Master Connecting Rod
Articulated Connecting Rods
Inlet and Exhaust Cam
Inlet and Exhaust Valve
Rocker Arms

These parts were forged from 3½% nickel and nickel-chrome alloy steels.

◆ ◆ ◆

GOLD MEDAL AWARDS received by Bethlehem at the recent Sesqui-Centennial Exposition, Philadelphia, in recognition of the high quality of Bethlehem Alloy Steels and Drop Forgings, are further evidence of the excellence of these products.

With the indomitable courage of a true hero and with profound faith in the excellence of the Wright engine which propelled his Ryan plane, Captain Charles Lindbergh made his epochal non-stop flight from New York to Paris.

During every minute of his journey, through sleet storm and under maximum engine stresses, Captain Lindbergh's successful trip, and probably his life, depended upon the perfect functioning of all motor parts.

Bethlehem drop forgings are a part of this famous engine. They did their work efficiently and proved again the excellence of quality and workmanship of Bethlehem products.

The Bethlehem organization is happy to have contributed to the success of Captain Lindbergh in his epochal and heroic accomplishment.

BETHLEHEM STEEL COMPANY
General Offices: BETHLEHEM, PA.

DISTRICT OFFICES:
New York Boston Philadelphia Baltimore Washington Atlanta Pittsburgh
Buffalo Cleveland Detroit Cincinnati Chicago St. Louis San Francisco
Los Angeles Seattle Portland

Bethlehem Steel Export Corporation, 25 Broadway, New York City, Sole Exporter of Our Commercial Products

BETHLEHEM

New Gulf Output Only 2,640 Barrels

About Initial Production of One Well in Normal Times. Eleven of Twenty-one Completions Were Failures

By P. L. McGreal
Staff Correspondent, Gulf Coast Fields

HOUSTON, Tex., June 11.—The dullness that has seized the Gulf Coast division is reflected in the small amount of new production developed during the week. The total is only 2,640 bbls. or about the initial output of one well in normal times. The completions for the week of June 11 total 21, of which 11 were failures and abandoned and one a salt water well. Nine wells are bailing at close of the week.

The estimated daily average gross production for the week is placed at 153,490 bbls., compared with 154,585 bbls. last week. The estimate for each pool is as follows:

Pool—	Dy.Ave.
Boling	1,750
Batson	1,355
Blue Ridge	5,250
Big Creek	4,675
Barber Hill	400
Dayton	30
Damon Mound	880
Edgerly (La.)	875
Goose Creek	8,600
Humble	4,400
Hull	16,800
High Island	240
Jennings (La.)	920
Lockport (La.)	6,120
Markham	450
Nash	1,300
Orange	6,935
Orchard	245
Pierce Junction	8,075
Piedras Pintas	70
Spindletop	58,600
Saratoga	1,100
Sour Lake	4,445
South Liberty-South Dayton	3,950
Stark (La.)	950
Welsh-Anse La Bute (La.)	30
West Columbia	9,520
*Miscellaneous	1,400
Vinton (La.)	5,015
Total	153,490

*Includes Nacogdoches, Washington and Kleberg Counties, Texas; Cameron, Calcasieu and Iberia Parishes in Louisiana.

South Louisiana pools credited with 14,510 bbls. of the total.

Southwest Fields

The estimated daily average for the Southwest Fields is 34,850 bbls., as follows:

Field—	Dy.Ave.
Luling	16,450
Mirando	14,000
Somerset	1,200
Callihan	30
Rockdale-Minerva	1,070
Lockhart (Lytton Springs)	2,100
Total	34,850
Grand total for week	188,340
Grand total last week	189,650
Net decrease	1,310

The Rio Bravo Oil Co.'s No. 6 Settegast, which came in flowing 800 bbls. at 4,300 feet, is now making around 40,000,000 feet of gas, showing 2,000 pounds pressure. The Houston Pipe Line Co. has connected with the well and is piping the gas to local industries. Rio Bravo company's No. 7 Settegast is swabbing at 4,190 feet. The Gulf Production Co.'s No. 3 Jones fee is heading 600 bbls. at 4,100 feet after being worked over. Anderson & Plummer's No. 1 Whitehead is bailing at 3,842 feet. J. F. Bashara's No. 2 Bender was abandoned in salt water at 4,200 feet.

In the Goose Creek Pool, the Humble Oil & Refining Co.'s No. 10 Beaumont will be tested at 4,300 feet. The Lake Shore Oil Co.'s No. 3 Duke is making 80 bbls., 25 per cent water, at 3,450 feet.

Nash Pool

The Rycade Petroleum Corp. got a 450-bbl. well in No. 14 Wisdom in the Nash Pool at 4,269 feet. It is on the line of Brazoria and Fort Bend Counties.

Hyde and others completed their third salt water well in the shallow sand section on the Boling Dome in Wharton County. The Sun Oil Co.'s No. 3 Felder on the northeast flank is drilling around 2,200 feet.

The Humphreys Corp.'s No. 4-B Kirby went into rock salt on the east side at Barber Hill and is plugging back for a test higher.

The Gulf Production Co. abandoned No. 9-B Blakely at Blue Ridge at 3,800 feet.

The Sterling Oil Co.'s No. 6 Hooks in the Batson Pool is pumping 85 bbls. of fluid and a small amount of oil at 1,490 feet.

In the Hull Pool, the Empire Gas & Fuel Co.'s No. 25 Barngrover is heading 550 bbls., 10 per cent water, at 3,160 feet. The Big Dome Oil Co. abandoned No. 1 Palmer at 800 feet. The Republic Production Co.'s No. 33 Dolbear is bailing at 2,450 feet.

Two tests were abandoned in the Big Creek Pool in Fort Bend County. The Gulf Production Co. quit No. 1 Davis at 4,800 feet, and The Texas Company plugged No. 1 Wheat at 3,800 feet.

The Gulf Co.'s No. 2 Marshall in the South Liberty-South Dayton section is pumping 20 bbls., 80 per cent sediment and water at 2,750 feet.

The Texhoma Oil Co.'s No. 13 Chesson in the Orange Pool will pump at 3,400 feet, and No. 16 Chesson was abandoned at 3,350 feet, following a workover.

Deering and others' No. 4 Gray in the Markham Pool is making 1,000,000 feet of gas. No. 2 Gray is pumping 60 bbls. of oil.

The Sun Oil Co.'s No. 12 McLean at Spindletop is bailing at 5,350 feet.

South Louisiana Pools

In the Edgerly Pool, the Gulf Refining Co.'s No. 8-B Higgins is heading 300 bbls. of fluid, 25 per cent oil, at 3,100 feet. The Crotty Oil Co.'s No. 12 Lilliard is bailing at 2,300 feet, as is the Rex Petroleum Co.'s No. 6 Hunter at 4,200 feet.

Cline & Son's No. 2 Wilson in the Jennings Pool bailed dry at 1,875 feet.

In the Lockport Pool, the Vacuum-Gulf joint No. 3 Bayou D'Inde is making 800 bbls. at 4,375 feet. No. 1 Farquhar is good for 75 bbls., 8 per cent water, at 4,300 feet. Screen is being set in joint No. 2 Farquhar at 3,750 feet. No. 2 Friedberg & Wolf is bailing at 4,825 feet.

The Yount Lee Oil Co. abandoned No. 6 School lands at Hackberry Island Dome in Cameron Parish at 5,312 feet.

The Texas Company plugged No. 2 Gullory at Pine Prairie Dome, Evangeline Parish, at 4,830 feet.

Operations in the Pools

In the Spindletop Field activity is largely confined to the south side of the present deep sand area. There the Magnolia Petroleum Co.'s No. 3 fee is standing at 5,300 feet. No. 5 fee is drilling at 5,010 feet. No. 6 is a derrick. No. 1 Tank farm is at 4,655 feet. The Gulf Production Co.'s No. 11 Oakwood, offsetting on the northwest, is at 3,899 feet. No. 12 is around 2,000 feet. No. 7 Mann is at 3,875 feet. No. 3-A McLean is at 3,255 feet. No. 5-A McLean is below 5,232 feet. No. 8 McLean is drilling at 6,000 feet. The Sun Oil Co.'s No. 15 McLean is at 2,355 feet. No. 13 McLean is at 4,235 feet. No. 14 McLean is around 3,345 feet. No. 1 Price is deepening at 4,600 feet. No. 3 Price is a location. The Grayburg Oil Co.'s No. 1 McLean is fishing at 4,300 feet.

The Texas Company's No. 1 Garrick, one-half mile north of production, is drilling at 4,985 feet. J. O. Davis' No. 1 Gladys, west of production, is drilling around 6,150 feet. The Walker Co.'s No. 1 Quinn is idle. The Rio Bravo Oil Co.'s No. 50 T. & N. O. is drilling around 4,435 feet.

The Yount Lee Oil Co.'s No. 8 Gladys is at 5,135 feet. No. 26 at 5,176 feet. No. 30 will test at 2,516 feet. No. 3 Davis is pulling the liner and No. 6 Davis is working over. No. 15 fee is at 5,968 feet. No. 26 fee is around 1,000 feet. No. 13 McFaddin is deepening at 4,680 feet. No. 29 is around 4,900 feet. No. 33 is drilling at 4,090 feet. No. 34 is at 1,160 feet, and No. 35 is below 1,200 feet.

At Pierce Junction, on the northwest side, M. Kouri's No. 2 Jones is deepening from 2,850 feet. The Marland Oil Co.'s No. 1 Prudent is deepening. J. N. Bashara has a location for No. 1-B. The Rio Bravo Oil Co.'s No. 5-B is pulling liner at 3,550 feet. A derrick is up for No. 8. Lee & Woodward's No. 2 Settegast is drilling around 2,890 feet. Smith and others' No. 2 Parson is rigging. On the east side, the Texas Exploration Co.'s No. 10 Dooley will deepen from 4,000 feet. The Gulf Production Co.'s No. 20 Taylor is deepening. The Navarro Oil Co.'s No. 2-A Cain will be drilled deeper.

D. J. Harrison has set casing in No. 1 Quintette in the old North Dayton Pool at 4,150 feet. The Union Sulphur Co. is drilling No. 2 Schliner there, and the Liberty Bell Oil Co. No. 1 Ager. The Humble Oil & Refining Co.'s No. 1 Kirby at Barber Hill is at 3,476 feet.

Hamill and the Moody Corp.'s No. 1 Sisk at Markham is at 2,925 feet, and Deering and others' No. 3 Grey is coring at 4,000 feet. The Texas Company's No. 2 Staiti is drilling at 3,345 feet. The Sun Oil Co.'s No. 11 Cade at High Island is drilling around 2,655 feet.

Goose Creek Pool

In the Goose Creek Pool the Gulf Production Co.'s No. 14 Chapman-Bryan is drilling at 2,165 feet. Its No. 7 Houston-Smith will be drilled deeper. The M & B Oil Co.'s No. 6 Scorrgea is at 2,476 feet. The Humble Oil & Refining Co.'s No. 71 Smith is drilling at 3,615 feet, and No. 72 is rigging.

In the Big Creek Pool, The Texas Company's No. 2 fee will be deepened. No. 4 fee is drilling below 3,980 feet.

The Gulf Co. is rigging No. 4 Granger in the Orange Pool. The Tillery Oil Co. has a derrick standing for No. 3 State land in Cow Bayou. The Rycade Petroleum Corp. will deepen No. 14-B Cow Bayou.

At Blue Ridge, the Overly Production Co.'s No. 1 Blakely is at 4,175 feet. The Navarro Oil Co. will deepen No. 2-A Robinson and has a location for No. 2-B Robinson. W. E. Woodruff, trustee, has a location for No. 2 Adams.

The Texas Company's No. 23 Arnold at West Columbia is at 3,600 feet. It is the only rig running in the pool.

In the Batson Pool, the Texas Company is rigging No. 1 Sterling, and the Sun Oil Co.'s No. 76 Paraffine is rigging.

The proposed deep test on the east side of the Saratoga Pool by the East Side Oil Co. on the Ogden lease is drilling around 2,500 feet. The Cove Oil & Gas Co. has a location for No. 1 Cotton.

In the Hull Pool, the Gulf company's No. 10 Phoenix is deepening at 2,285 feet, and No. 85 is drilling at 3,900 feet. The Republic Production Co.'s No. 84 Dolbear is at 2,345 feet. The Texas Company's No. 3 Taylor is at 3,500 feet. No. 5 Hannah is at 3,500 feet. H. J. Antillery will deepen No. 5 Abel.

THREE TESTS FOR HOSPAH SECTION; WILDCATTING IN THE RED MESA

By Special Correspondent

FARMINGTON, N. Mex., June 11.—In harmony with the policy being practiced by the large producers in other fields the big companies are not going after further production on the proven structures in the San Juan Basin Field. The Continental Oil Co., which had been carrying on an active drilling campaign on the Rattlesnake and Table Mesa structures, at first slowed down and finally laid off most of its drilling crews. This is not a permanent arrangement, of course, but it will probably last until a solution of surplus production has been solved. While this is true of the proven structures the big companies are nearly all engaged in scouting or drilling in the wildcat territory of this field.

The Midwest Refining Co. is drilling two wells in the Hospah section of the Seven Lakes district and has a third located and getting ready to drill. Its No. 2 is nearing the Mesa Verde sand that proved productive in No. 1. No. 1 is being pushed down to test the Dakota sands. The Ohio Oil Co., which has been actively wildcatting on the Red Mesa structure, has turned its attention to the Hospah district and has made a location, after much scouting, in Section 26-17-9. It is expected that drilling on this location will follow as in letters to leaders on the Red Mesa the company announces it is abandoning that structure and its drilling in the Hall well which it took over something like a year ago. This well was drilled to a depth of 3,850 feet, stopping in the McElmo formation. It is plugging back to the bottom of the Dakota sands at about 3,000 feet.

Red Mesa Test

In the meantime, the Miley Oil Co. is going ahead with its test on the Red Mesa structure, Section 32-33-12, in an effort to pass the lost tools in the bottom of a 2,900-foot hole, and reach the Dakotas that are believed to be less than 100 feet from the bottom of the original hole.

For the past few days the T. C. N. Oil Co. has been underreaming in the test on the Ed Lanier permit in the Bloomfield district, Section 9-29-11. The underreaming has been completed and drilling was resumed Wednesday at a depth of 645 feet. In comparing the log of the Ed Lanier test with others in the same vicinity, it was discovered by the geologists on this work that correlations of certain horizons is warranted. Taking this fact into consideration in conjunction with certain elevations it is believed that the Ed Lanier test presents very good indications for favorable results when completed.

The Union Oil & Mining Co., operating in the Blanco district, Section 8-29-9, has succeeded in recovering all but the last string of tools in the hole and confidently expects to clear the hole before the end of the week. When this last string of tools is out of the hole drilling will be resumed to test the sand from which a small production of some 4 or 5 bbls. has been flowing for several months with the tools in the hole. If satisfactory commercial production is not obtained in the sand at the bottom of the hole it will be drilled considerably deeper.

The Huntington Park Petroleum Corp., which controls acreage northwest of the Union Oil & Mining Co. test well, is shipping in a rig and equipment to put down another well on its holdings. It was

(Continued on Page 342)

Showing of Oil in Oregon Water Well

Geologists Active Near Fossil. New York Oil Co. Reconsiders Plans. New Gas Line From Lance Creek

By F. B. Taylor
Staff Correspondent, Rocky Mountain Area

CASPER, Wyo., June 11.—The New York Oil Co. has furnished the high light in the oil news of the Rocky Mountain region for the past week and a complete reversal of the oil company's plans and management of field work is now looked for following the meeting of the stockholders held in Casper.

The New York Oil Co. was founded by the late Frank G. Curtis of Jamestown, N. Y., who came to visit the west as a tourist, but remained to become an oil operator in Salt Creek and establish one of the largest independent oil companies in the Rocky Mountain region. Mr. Curtis managed the affairs of the New York Oil Co. with a hand that soon placed the company on a substantial basis financially and to his brother, Don Curtis, and to Minal Young he delegated the management of the firm's affairs. Mr. Young was general manager of the New York Oil Co. since its formation and up to a year ago.

Last year, some of the stockholders of the company considered making a change and the whole management of the New York Oil Co. was changed. This change came as a surprise to many and especially to Mr. Young and several of the head officers of the company. The meeting just held at Casper has practically reversed the change of a year ago and again the management of the New York Oil Co. is in the hands of Don Curtis and Minal E. Young.

For a time it appeared that the whole matter would be settled only after a long trial in the courts. An injunction was applied for at Casper after two sets of directors were elected by the opposing factions, but after considerable discussion, an amicable settlement was reached by which the former management which has been ruling the company's affairs since its formation, was again placed in power and Emil Steiger, president of the New York Oil Co. for the past year, was placed as chairman of the board.

The United States Land Office at Cheyenne, received a check from the Ohio Oil Co. the past week for $136,000, being the money due the United States for royalties from oil produced on government lands. This sum came from the sale of oil from a 40-acre tract in the Rock River Field in Albany County, Wyoming.

Showing in Oregon

Oregon is still being looked over as a possible oil producing state, at Fossil, Ore., where a water well recently produced a showing of crude oil at a shallow depth. Casing has been set to the top of the sand and a test of the show is now being made. This well is 268 feet deep. At Burns, near Fossil, geological crews are active and have awakened much interest among the natives of that area. The geologists are particularly active in the Harney Basin and are reported to be sent in there by California oil firms.

Walden Well Increases

The big well at Walden, in northern Colorado, drilled by the Continental Oil Co. last year, has been deepened about 5 feet and the production has jumped from about 400 bbls. to 600 bbls. daily. This is the well that came in with a carbonic gas production that startled the oil men as such a freak had never been encountered in the oil fields. The increase in production of the Walden well is to be tanked on the surface and the well drilled down for a complete test of the sand. This sand is thought to be about 57 feet thick and at present the bit has penetrated it about 10 feet only.

In Utah, the Snowden & McSweeney well on the Cane Creek Dome is setting and cementing casing. After this is finished the well is expected to reach the pay found in the Cane Creek discovery well within a few feet below the present bottom of the hole. The Cedar Mesa well of the Utah Southern Oil Co. and others is drilling at 2,855 feet in a gray sandy lime.

The Essok Oil Co., drilling near Boulder, Colo., is resetting casing and will be drilling again in a few days.

New Work in Wyoming

In Wyoming a noticeable amount of new work has started in the past week. It appears that a long gas line is in prospect from the Lance Creek Field in Niobrara County to Wheatland and other points in Goshen County. This line is now in the first stages of promotion and the towns and cities through which it will pass are being lined up for franchises to serve the people with natural gas.

For some months no well has been drilled in the Lance Creek Field, but the Buck Creek Oil Co. is starting a well on Section 7-35-65. The Lance Creek Field is somewhat of a problem; several times it has been given up as the dry holes came in without any apparent break, but always in the end some lucky location would come in with big production and revive hopes. The field has a granite dike near the center and about a mile southwest of the old Midwest camp, and besides this strange freak of geology the sands are anything but regular.

The new gas line proposed from Lance Creek would serve the towns and cities of the North Platte Valley in both Wyoming and Nebraska. The principal backers of the project are men from Scotts Bluff, Nebr., and they are dealing with the Argo Oil Co. for that company's gas production in the field.

At present the gas production at Lance Creek is being utilized by one gasoline plant and a carbon black plant. Some doubt is expressed as to whether the Lance Creek wells would carry a gas line service and these two field plants at the same time for the present consumption of gas is large and were a gas line pull to be added it is thought by some the wells would decline to nothing in a short time.

On the Boar's Tusk structure, 30 miles north of Rock Springs, Sweetwater County, the Boar's Tusk Oil Co. will start a wildcat to see whether the Baxter Basin pay extends that far or not. This location is in Section 16-23-104 and the hole will be put down with a core drill.

The Ohio Oil Co. is starting equipment for the Cody structure drilled by M. Guiterman and others last year, where a well was found at 1,200 feet. This operation lies close to the proposed end of the new pipe line from the Oregon Basin Field, where the line will meet the railroad and the pay is found in sand lenses in the shale. It is a paraffin base crude.

Hiawatha Dome

The Hiawatha Dome on the Wyoming and Colorado line is also to be drilled this season. The Ohio Oil Co. is moving in machinery there at this time and two other companies have signified their intension to drill. This structure has been proven gas bearing by the Myers well drilled last summer and the Salt Lake City gas line project includes the Hiawatha Dome as one of the fields from which the line is to take its gas.

In the LaBarge Field, the LaBarge Oil Co. is moving in four drilling rigs to put down that number of wells this season. The Transcontinental is to abandon its deep test as a dry hole and the California Petroleum Co. is expected to start work on a pipe line about the first week in July.

In the Big Hollow structure, south of Laramie, Albany County, the Laramie Oil Development Co. has asked government permission to abandon the black oil producers in the Big Hollow. These are shallow wells that have been drilled for some 10 years and for a time made some black oil production from a shallow depth that was shipped into Colorado for refining. The field never amounted to much in the shallow development and the wells are considered about exhausted. The company asks permission to abandon 20 wells.

Salt Creek Producers

The Midwest Refining Co. completed four new producers in the Salt Creek Field the past week. In Section 35-40-79, the Midwest Oil Co. has a Lakota well good for 435 bbls. at 2,426 feet. The same company also has a producer at 1,202 feet on the same section.

The Wyoming Associated Oil Co. has a Lakota well in Section 26-40-79 that will make 415 bbls. from a depth of 2,484 feet and a small pumper in the same section that will make 25 bbls. from a depth of 1,153 feet. The two Lakota wells were shut in.

The Continental Oil Co. is starting No. 56 on the Whiteside lease in the Big Muddy Field, Section 9-33-76, and this makes three wells now drilling there by this company. Electricity is being used for power.

A report from the LaBarge Field states that Charles Lackey drilled in a producer there, but it has not been measured yet. It is located in Section 12-28-114.

In the Brenning Basin in Converse County, central Wyoming, A. A. Tyler and others have a rig up for a deep test in Section 9-31-73.

Kevin-Sunburst

Weather and road conditions in Montana continue to hamper field work, but the general situation is improving. Six new wells were spudded in in the Kevin-Sunburst Field and a number were completed. The Homestake Exploration Co. reports two flowing wells in a stray sand above the Ellis proper, on State land. No. 27 flowed 25 bbls. an hour for some time after completion, and No. 28 sent oil over the top of the derrick, subsiding to a flow every 24 hours. It is probable that both wells will be drilled into the Ellis for a thorough test.

The Barnhill interests report a small producer in No. 2 Skinner in Section 18-34-1, in the Ellis sand. This well will no doubt be drilled to the Ellis-Madison break, where big production has been encountered in so many wells in the field.

The Maharg-Rock No. 2, in Section 26-35-3, on the west side of the field, will make a 40-bbl. well or better. This well is producing from the Ellis sand, and is noteworthy mainly because it is located in a part of the field where there has been little development for some months.

The California Co.'s Lorenson No. 8, in Section 28-35-2, in the Moe-Lorenson Pool, was drilled deeper and at last report had swabbed 175 bbls. in five hours. This well is expected to produce about 500 bbls. a day on the pump. O'Neill-Hill-Lorenson's No. 8, in the same section, is reported to be making over 1,300

(Continued on Page 353)

DEVENISH WELL, SOUTHERN ALBERTA, ESTIMATED 125 TO 150 BARRELS

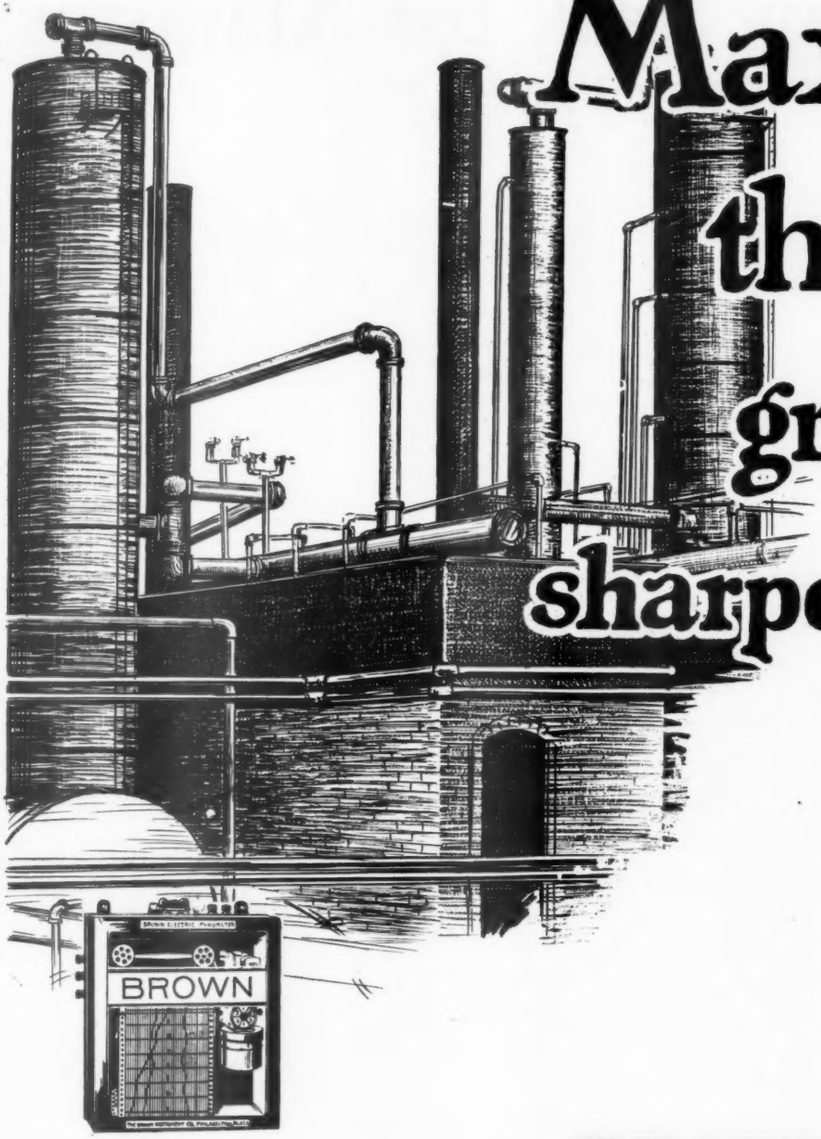
By Victor Lauriston
Staff Correspondent, Canadian Fields

CHATHAM, Ontario, June 11.—As reported in last week's issue of The Oil and Gas Journal, Devenish Petroleum, Ltd., drilling in LSD 5, Section 27-5-14w4, south of Skiff, in the border field of southern Alberta, has penetrated an oil sand at 3,090 feet with what looks like a fair commercial production of heavy crude. Within a few hours the crude stood at 2,200 feet in the 8¼-inch casing, and the bailing of between 40 and 50 bbls. in two and one-half hours failed to lower the level. The strike is apparently the most important yet made in southern Alberta outside the Turner Valley Field. The test has not yet been drilled into the sand to any extent.

Following the strike, a swab was procured from Kevin and an eight-hour swabbing test made under the direction of T. G. Madgwick of the engineering branch of the Federal Department of the Interior. In the eight-hour test some 50 bbls. of crude were taken from the well, and, according to Mr. Madgwick, the indications pointed to a possible production of 125 to 150 bbls. a day. Samples of the oil were taken to Calgary for analysis, which has not yet been completed. It is a black crude, apparently of asphaltic base, with a slight greenish tint and a slight gasoline odor, and appears to be about 25 gravity, somewhat lighter than the average heavy crude of the Irma-Wainwright Field.

The location is 7 miles south of Skiff, about 40 miles southeast of Lethbridge, and not far from the Montana boundary, on a structure determined by Dr. J. A. Allan of the geological department of the University of Alberta. The structure is thought to extend northwest and southeast to the Sweetgrass Hills uplift, which would link it with the structure on which the Rogers-Imperial gasser was drilled some years ago in Section 29-1-11w4. The Devenish Petroleums well is considerably lower on the structure. Drilling followed filing, early last spring, by O. G. Devenish and associates of Calgary, on 80,000 acres, involving fees of $50,000, being the largest filing in the history of Alberta. The test spudded in July 31 with a standard outfit and was at 2,300 feet when tools were stacked for the winter. Drilling was resumed in April. The 8¼-inch casing has been run to 3,045 feet, and so far there is no water trouble, though a heavy artesian flow, estimated at 30,000 bbls. a day, was struck and cased off in the upper horizons. The production horizon has not been determined, but is thought to be the Dakota sand. Reports of the strike started a scramble for acreage at the Lethbridge Land Office. Devenish Petroleums holds 60,640 acres on the Etzikom Coulee lease in Townships 5 and 6, Ranges 13 and 14, west of the Fourth, and 14,080 acres in Verdigris Coulee, mostly in Township 4-16w4, the well being on the Etzikom Coulee acreage. The Devenish leases are due north of the Kevin-Sunburst Field in Montana, a distance of 35 miles, and from 16 to 32 miles north of the Mon-

(Continued on Page 342)



Maximum throughput, greater yield, sharper end-points

These are the three vital factors in refining today.

They are the factors on which profits depend.

And the successful accomplishment of every one of the three—regardless of the refining process employed—absolutely demands the utmost in close temperature control.

BROWN AUTOMATIC TEMPERATURE CONTROL

in combination with modern methods of "cracking" and continuous distillation with dephlegmating, fractionating and bubble towers, is making records in reducing re-runs and reflux, increasing percentages of light products, producing uniform output to rigid endpoint specifications, saving fuel, and simplifying close and dependable operating control at a lower labor cost.

Address The Brown Instrument Co., 4412 Wayne Avenue, Philadelphia, Pa., or one of our District Offices in New York, Boston, Pittsburgh, Cleveland, Detroit, Chicago, Indianapolis, Birmingham, Tulsa, Houston, El Paso, Los Angeles, San Francisco, Denver, Salt Lake City, Montreal.

Brown Pyrometers

INDICATING : RECORDING : AUTOMATIC CONTROL

Short-Lived New Peak for Alamitos

May Send Seal Beach Production Up to 90,000 Bbls., But Decline Expected Before End of the Month

By L. P. Stockman
Staff Correspondent, California Fields

LOS ANGELES, Calif., June 11.—Seal Beach is off again on another wild rampage and new wells and recompletions at Alamitos Heights are coming in bunches, like bananas. Eastern operators should not get the impression, however, that California has another Santa Fe Springs or an area comparable to Seminole, for such is not the case. Seal Beach production will never reach any very great heights because the productive acreage in the older section of the field is held in large blocks by conservative operators. Alamitos Heights, or the so-called town lot area, is primarily responsible for the present high flush production of Seal Beach, but this section cannot possibly sustain intensive drilling for more than a short time unless a new sand is found. The industry should therefore not get alarmed for, unless all signs fail, Alamitos will pass out of the picture in the very near future. In other words, just sit tight for another few weeks.

The California production peak was passed some time ago and, barring the opening up of another highly prolific field, the rest of 1927 should not prove unduly embarrassing as far as California is concerned. Do not get the impression, however, that California is independent of other domestic or foreign markets for, with 90,000 bbls. per day shut in, this State is still producing far in excess of its normal requirements.

Alamitos Heights is without doubt one of the most erratic areas ever opened up for work in California and no one seems to be able to figure the critter out. One day it is plunging downward at an alarming rate only to recuperate and start back up 24 hours later. Part of this erratic tendency is due to the irregular completion of new wells and recompletion of former producers which go off and come back with great regularity. On several occasions six and eight producers have all ceased flowing simultaneously only to be brought back flowing a little later on. The effect of such an unstable situation on daily production can easily be imagined. The exceptionally large increase in daily production which this field has registered during the past two weeks is due to a combination of causes but can be attributed primarily to the completion of an unusually large number of new wells and the recompletion of several flowing projects which went off production a short time ago.

Seal Beach's New Peak

Seal Beach, as a result of the intensive work under way in the town lot area, is destined to set a new high peak production in the very near future due, principally, to the fact that several operators have already started to take advantage of the deeper penetration in the Selover zone at Alamitos Heights with the result that a large number of wells are already on the way down. The Pan American, in drilling No. 1 Marquis, found that the Selover zone on top of the structure in the town lot area was considerably thicker than has heretofore been believed and this additional thickness of sand will be reflected in higher production. During the early stages of development operators were afraid of running into bottom water at Alamitos Heights and as a precautionary measure only a limited penetration was taken. This varied from 15 to 25 feet in most instances. Later some of the more brave ventured down 70 feet with success and recently the Pan American found approximately 180 feet. Just how long this sand will hold up remains to be seen and while no one seems willing to venture a guess on the time element it is the consensus of opinion that the new flush will be relatively short lived.

The success which operators are achieving as a result of the lately discovered additional penetration at Alamitos Heights raises a very pertinent question which, if answerable, would permit the forming of a conclusive estimate of the new peak production to be reached and a fairly accurate computation of the total ultimate recovery of oil to be effected under approved methods. In view of the limited information available at present, however, it is rather hazardous to venture even a guess on the anticipated peak as any statement at this time would simply be a guess in the dark. Several operators are withholding whatever deductions they have formed and hence it is rather difficult to secure the exact amount of sand opened up. Before any reliable estimate can be made of what the future holds in store for Alamitos Heights one must know the total thickness of the Selover sand in this section and the probable area covered. With some operators zealously guarding this information and rather incomplete reports from others, the situation is such that no one knows what to expect. The failure of some companies to lay their cards face up on the table, while regrettable, is to be expected, as in this mad rush for production it is a case of every man for himself and the first to take advantage of the maximum penetration available will naturally get the cream. What the industry would like to know is the total thickness and extent of the Selover zone at Alamitos Heights. Deep wells around the edge of the structure indicate that it will probably be somewhat limited in area but up to the present the total thickness on top of the structure is still undetermined as no one has yet drilled entirely through it.

Guessing at New Zone

Late completions are not taking a penetration of over 180 feet and it is the general belief the maximum depth will not exceed 200 feet. As has been stated, any estimates made at present are merely conjectural and can not be formed with any degree of accuracy because of the limited amount of information available. Based on a maximum thickness of 200 feet and extending over a rather limited area, the Selover zone at Alamitos Heights should push the Seal Beach production up to around 90,000 bbls. per day in the near future, but the writer is of the opinion that the new high will merely be a flash in the pan and of short duration. Unless I have the wrong slant, Alamitos Heights will go over the top within 10 days and start down again before the close of June. Twenty-one wells are already going after this deeper penetration in the town lot area and this work, together with the operations of the Marland, Associated and Standard in the older section of the field, which should result in the completion of a like number shortly, should have a tendency to bolster up production temporarily. Heretofore, the daily output has fluctuated violently because of the relatively small number of producing wells in the field. Because of this situation the sanding up of three or four flowing wells exerted an appreciable effect on the field output but during the course of the next few weeks additional new completions should prevent a repetition of this condition.

Mount Poso Pipe Line

Surveys for a $2,000,000 pipe line project that will provide a long-needed outlet for the production of the Mount Poso Field, 15 miles northwest of Bakersfield, are being made by the Shell Co. of California. Tentative plans call for the laying of an 8-inch pipe line to run from the heart of the Mount Poso Field 50 miles across the valley to Lost Hills, where the line will connect with a proposed 10-inch line planned to handle oil between Coalinga and Taft. When the Shell company opened up the Mount Poso Field last year the writer called attention to the probability that this company would eventually extend its Martinez-Coalinga line down to Mount Poso via Midway-Sunset and recent indications point to the fulfillment of this prediction. The Shell has developed a production in the Mount Poso Field of around 2,500 bbls. a day and it is but logical to assume it will make use of this oil soon as it has excellent lubricating qualities.

The Shell also has some very promising holdings in the newly-discovered Round Mountain Field, 16 miles northeast of Bakersfield, and it is possible the line now contemplated will be extended into this area if commercial production is developed on its leased acreage in that section. The Shell's new pipe line from Coalinga to Mount Poso will require about six months to carry to completion after authorization for construction has been issued. Plans at present are still in the formulative stage and if the company carries out its present intention this will be the largest pipe line undertaken

(Continued on Page 338)

IMPORTANT SOUTHERN CALIFORNIA WILDCATS

Company, Well, Location—	S-T-R	Depth	Status
Smith Pet. Co., No. 1 Johnson, Hawthorne	17- 3-14	6,215	suspended
General Pet., No. 1 Guiberson, Potrero	35- 2-14	Rig	wait. devel.
Calif. Eastern, No. 1 Cypress, Potrero	27- 2-14	4,385	sd. sh. drilling
Associated, No. 1 Cypress, Potrero	34- 2-14	4,450	suspended
Associated, No. 2 Cypress, Potrero	2- 3-14	3,720	br. sh. drilling
Getty, Geo. F., No. 1 Cypress, Potrero	35- 2-14	Rig	wait. devel.
Getty, Paul, No. 1 Cypress, Potrero	35- 2-14	Rig	wait. devel.
California Pet., No. 1 Sutton, Potrero	34- 2-14	Rig	wait. devel.
California Pet., No. 1 Armour, Potrero	35- 2-14	Rig	wait. devel.
Cole, Fred E., No. 1 Cypress, Potrero	36- 2-14	Rig	wait. devel.
Dill Oil Co., No. 1 Cypress, Potrero	35- 2-14	Rig	wait. devel.
Walker, Fred, No. 1 Cypress, Potrero	35- 2-14	Rig	wait. devel.
Dominguez Exten., No. 1 Compton, Dominguez	22- 3-13	5,530	suspended
Getty, Geo. F., No. 1 Tubbs, Rivera	25- 2-12	3,060	gr. sd. drilling
Circle Oil Co., No. 1 Pomeroy, Manchester	22- 3-14	4,128	suspended
Shell, No. 1 Mission, San Fernando	4- 2-15	1,141	land 18-inch
Sou. Calif. Drlg. Co., No. 1 Matteson, El Segundo	1- 3-15	4,870	fishing
Carr, O. P., No. 2 Foster, San Juan Capistrano	13- 8- 8	2,144	gr. sd. drilling
Cardiff Oil Co., No. 1 Oceanside, San Diego	24-13- 4	2,805	redrilling
O'Donnell, J. E., No. 1 Julian City, Los Angeles Co.	7- 4-14	4,500	sd. sh. drilling
Fisher & Co., No. 1 Rinz, Saugus	27- 5-16	329	sd. drilling
Southwestern Pet., No. 1 Ramsauer, Watts	4- 3-13	850	land 12½-inch
Reliance Inv. Co., No. 1 Leuzinger, Los Angeles Co.	8- 3-14	1,125	gas—shut in
Shell, No. 1 Allec, Placentia	31- 3- 9	1,201	sd. drilling
Standard, No. 1 Olive, Orange Co.	17- 4- 9	Rig	rigging up
Standard, No. 1 Rindge, Palms	36- 1-15	Rig	in litigation

IMPORTANT NORTHERN CALIFORNIA WILDCATS

Associated, No. 1 Smth, Kettleman Hills	12-23-18	2,043	suspended
Bolsa Chica, Well No. 1, Kettleman Hills	30-23-19	2,365	testing
General Pet., No. 1 Burbank, Kettleman Hills	30-23-19	3,105	25 bbls. daily
General Pet., No. 2 Oschener, Kettleman Hills	26-22-18	1,905	gr. sd. drilling
General Pet., No. 1 Dome, Kettleman Hills	4-24-19	.....	location
C. C. M. O., No. 1 McGlashan, Kettleman Hills	17-24-19	3,524	gr. sd. drilling
South Coalinga, Well No. 1, Kettleman Hills	35-24-19	2,230	gr. sd. drilling
Gilbert, W. M., No. 1 Barritt, Kettleman Hills	20-23-19	Rig	rigging up
Ahlburg Gas Co., Well No. 1, Kettleman Hills	7-23-23	Rig	standing
Milham Expltn., No. 1 Kettleman, Kings Co.	2-22-17	3,470	sd. sh. drilling
Shell, No. 2 Berlywood, Moorpark	32- 3-20	3,581	hd. sd. drilling
C. C. M. O., No. 1 Hobson, Ventura Co.	22- 3-24	6,470	br. sh. drilling
C. C. M. O., No. -B Hobson, Ventura Co.	16- 3-24	4,340	land pipe
Continental Oil Co., No. 1 Newhall, Ventura Co.	36- 4-18	2,595	testing
Continental Oil Co., No. 1 Burnham, Ventura Co.	22- 5-18	2,401	gr. sd. drilling
Milham Expltn., No. 1 Sexton, Ventura Co.	19- 3-22	7,100	fishing
Standard, No. 1 Camarillo, Ventura Co.	29- 2-20	5,210	hd. sd. drilling
Standard, No. 1 Montalvo, Ventura Co.	17- 2-22	5,780	hd. sd. drilling
Petroleum Sec., No. 1 Diablo, Ventura Co.	4- 4-18	2,170	hd. sd. drilling
Parkford, E. A., No. 1 Strathern, Ventura Co.	5- 2-18	3,005	hd. sd. drilling
Star Petroleum, No. 1 Canet, Ventura Co.	13- 3-23	4,790	sd. sh. drilling
Richfield, No. 1 Janes, Ventura Co.	16- 5-18	2,301	gr. sd. drilling
Richfield, No. 27 Piru, Ventura Co.	35- 5-18	1,495	suspended
Superior, No. 1 Pena, Ventura Co.	18- 4-17	5,030	abandoning
Milham Expltn., No. 2 Buttonwillow, Kern Co.	8-28-23	4,662	cleaning out
Milham Expltn., No. 3 Buttonwillow, Kern Co.	7-29-24	3,760	bl. sh. drilling
Pacific Eastern, No. 1 Bakersfield, Kern Co.	6-30-28	4,075	recemented
C. C. M. O., No. 1 Quinn, Delano	23-25-27	1,723	recemented
Muroc Dev. Co., No. 1 Rosedale, Kern Co.	13-29-26	1,498	suspended
Standard, No. 1 Bacon, Kern Co.	27-28-20	2,848	gr. sd. drilling
Petroleum Sec., No. 1 Aniotz, Monterey Co.	2-22- 9	2,300	hd. sd. drilling
Birch Oil Co., No. 1 Porterville, Tulare Co.	13-20-26	150	sd. drilling
Richfield, No. 1 Wreden, San Luis Obispo Co.	10-29-17	721	gr. sd. drilling
Shell, No. 1 Cowell, San Mateo Co.	16- 5- 5	3,551	hd. sd. drilling
Shell, No. 1 Murphy, Petaluma	29- 5- 6	5,350	hd. sd. drilling
Shell, No. 1 Ielmorini, Sonoma Co.	8- 5- 7	140	sd. drilling
Thomas & Hammill, Well No. 1, Alameda Co.	16- 3- 3	1,100	hd. sd. drilling

TANKER SHIPMENTS FROM LOS ANGELES TO ATLANTIC AND GULF COAST PORTS

Commodity—	Total This week	Daily Average	Total Last week	Daily Average	This year To date	Same time Last year
Crude oil	214,817	30,688	255,207	36,458	3,448,828	6,003,763
Fuel oil	212,076	30,297	269,093	38,442	4,043,356	2,662,217
Diesel and gas oil	.....	.....	.....	.....	1,386,653	1,179,293
Gasoline	340,576	48,654	170,045	24,292	3,407,338	2,783,398
Tops	.....	.....	.....	.....	.....	149,906
Coastwise—						
Crude oil	477,238	68,177	603,913	86,273	11,574,544	11,252,618
Fuel oil	180,777	25,825	262,415	37,488	5,211,149	3,892,574
Diesel and gas oil	.....	.....	32,457	4,637	128,060	125,672
Gasoline	102,698	14,671	240,837	34,405	3,490,923	3,233,048
Kerosene	.....	.....	5,629	804	50,697	138,950
Tops	.....	.....	.....	.....	.....	251,082
Exports—						
Crude oil	.....	.....	.....	.....	1,400,029	1,770,715
Fuel oil	445,378	63,625	277,278	39,611	11,499,080	6,781,120
Diesel and gas oil	.....	.....	19,221	2,746	543,482	145,201
Gasoline	291,936	4,171	347,998	49,914	1,735,770	2,056,762
Tops	.....	.....	.....	.....	227,204	.....
Kerosene	.....	.....	.....	.....	1,017,144	941,454

TANKER SHIPMENTS FROM SAN FRANCISCO TO ATLANTIC, GULF COAST PORTS

Diesel and gas oil	.....	.....	.....	.....	415,555	720,377
Gasoline	.....	.....	.....	.....	961,581	608,848
Tops	.....	.....	.....	.....	.....	73,698
Lubricants	.....	.....	.....	.....	111,970	157,147
Coastwise—						
Fuel oil	156,455	22,351	111,388	15,913	2,535,586	2,510,303
Diesel and gas oil	.....	.....	.....	.....	173,724	.....
Gasoline	31,947	4,564	57,661	8,237	2,102,941	1,814,965
Kerosene	.....	.....	.....	.....	90,621	178,420
Exports—						
Fuel oil	75,162	10,737	59,470	8,496	1,000,716	1,027,314
Gasoline	.....	.....	127,872	18,267	1,672,011	896,785
Kerosene	.....	.....	.....	.....	535,647	912,311
Lubricants	.....	.....	.....	.....	9,120	18,051

Few Better Than Average Wells in East

Perry, Holmes, Hocking and Licking Counties Continue to Furnish the Larger Producers in Southeast Ohio Field

By D. S. Wakenight
Staff Correspondent, Eastern Fields

PITTSBURGH, Pa., June 13.—The eastern fields completed but few wells during the past week. In the list there were no large producers and only a few better than average size. Southeast Ohio had most of the fair producers, while West Virginia and Southwest Pennsylvania had to be content with light wells. Operators are still holding back and awaiting general conditions to improve. There is no section that calls for active development. Producers are selling very little of their credit balances, hoping for an upward turn in the market.

Most of the work under way at this time will, when completed, give very little new production, for it is nearly all located in old territory and will hasten the death of old wells that have been producing for many years. Rather than start new work, drilling deeper is still much of a feature. Looking for production in some lower sand has no part in the work of today. In the entire eastern fields there is not a deep test drilling. The last is the Reserve Gas Co.'s deep test on the Smith Brothers farm in Union district, Harrison County, West Virginia. It will probably be abandoned at a total depth of 6,820 feet.

No Large Wells Completed

Just a few better than average wells were completed and no large producers during the week. The best reported are located in the deep sand territory in Southeast Ohio. The shallow sand districts had few completions. In the northeast quarter of Section 20, Madison Township, Perry County, the Atha Oil Co.'s No. 14 on the Melick Brothers' farm produced 105 bbls. the first 24 hours after shot in the Clinton sand. It also shows a gas pressure of 200,000 feet. In Lot 25, Hardy Township, Holmes County, the Empire Gas & Fuel Co. got a 60-bbl. producer when it completed a test on the Dagler heirs' farm.

In the northeast quarter of Section 10, Westland Township, Guernsey County, the Eastern Carbon Black Co. completed a 50-bbl. well when it drilled a second test on the R. F. Ruby farm through the Niagara lime formation. The same company's second test on the A. E. Kerr farm is good for 20 bbls. a day in the same formation. Neither the West Virginia nor Southwest Pennsylvania fields completed any large producers.

Late Completions

In the northwest quarter of Section 12, Washington Township, Hocking County, the Ohio Fuel Supply Co. has completed and shot in the Clinton sand a second test on the H. P. Hess, trustee, farm, and good for 60 bbls. a day. In the northeast quarter of Section 136, Medina Township, Medina County, the Empire Gas & Fuel Co. has a duster at a test on the C. C. Wilber farm.

In the southwest quarter of Section 6, Jackson Township, Guernsey County, the Ohio Fuel Supply Co.'s No. 6 on the Lenora J. Fulton farm is good for 35 bbls. a day in the Niagara lime. In the northwest quarter of Section 26, Washington Township, Hocking County, the Gordon Oil Co.'s No. 7 on the O. F. Pierpoint farm is good for 40 bbls. a day. The location is 700 feet southwest of No. 6 on the same farm.

In Section 10, Perry Township, Licking County, the Hope Construction & Refining Co. completed in the Clinton sand a second test on the H. W. Brown farm. It produced 42 bbls. the first 24 hours. In Section 14, Hanover Township, the Hope Construction & Refining Co. completed in the Clinton sand a second test on the Charles O'Bannon & Co. farm. It produced 92 bbls. the first 24 hours after shot.

Duster in Muskingum County

In the southeast quarter of Section 11, Meigs Township, Muskingum County, John Swisher and others have completed in the Niagara lime a test on the William Lyons farm. It is a duster in all sands. It was drilled to a total depth of 4,456 feet. In Section 7, Lawrence Township, Washington County, J. O. Harlon and others have a gasser in the Berea grit at a test on the Lewis Baker farm.

In Section 13, Franklin Township, Licking County, in the Southeast Ohio shallow territory, the Detex Oil & Gas Co. and others have completed in the Berea grit No. 10 on the Otto Franks farm, not good for more than 2 bbls. a day. In Lot 14, Newton Township, E. J. Edmons & Co. have drilled a test on the Blire heirs' farm through the Berea grit and dry. It will be drilled to the lower sands.

In the Fisher Pool, Alexander Township, Athens County, the Biddle Oil & Gas Co. have completed No. 9 of the John F. Biddle heirs' farm, good for 3 bbls. a day. In Lot 4, Section 14, Chatham Township, Medina County, E. R. Edson, Son & Co. have completed at 387 feet No. 32 on the Carl G. Packard farm. It is a very light pumper.

The Eastern Carbon Black Co. completed in the Niagara lime a second test on the R. F. Ruby farm. It is a natural producer and placed 50 bbls. to its credit the first 24 hours. In the southeast quarter of the same section, the Eastern Carbon Black Co. has a 20-bbl. producer in the same formation at a second test on the A. E. Kerr farm.

Guernsey County

In Wheeling Township, Guernsey County, the Logan Gas Co. has a rig up on the W. T. Booth farm. In Liberty Township, the Ohio Fuel Supply Co. has rigs completed for tests on the A. C. Kinney and W. S. Ouders farms. In Wheeling Township, the same company is drilling a test on the Samuel Rich farm. In Section 16, Westland Township, the Gambet Oil & Gas Co.'s test on the David Tedrick farm, dry in the Niagara lime and abandoned. In Adams Township, the Ohio Fuel Gas Co. has made locations on the Samuel Armstrong, E. A. Tomkin, C. G. Johnston, Leonard Black and George Shuman farms.

In the northeast quarter of Section 20, Madison Township, Perry County, the Atha Oil Co. has completed and shot in the Clinton sand No. 14 on Melick Brothers' farm. It produced 105 bbls. the first 24 hours and has a gas pressure good for 200,000 feet. In Section 19, Reading Township, Perry County, the Hope Construction & Refining Co. has started to drill a test on the Edward Petty farm.

West Virginia

In Henry district, Clay County, the United Fuel Gas Co. has completed in the Big Injun sand a test on the Gross, Summers & Co. farm. It is a light gasser, located on Valley Fork of Laurel Run, 4,000 feet south of the same company's test on the J. M. Gross farm. In the same district, the same company's test on the J. M. Gross farm is also a light gasser in the Big Injun sand.

On Laurel Run, Sherman district, Calhoun County, O. B. Lewis and others have completed a test on the M. Westfall farm, good for 2 bbls. a day in the Big Injun sand. In Paw Paw district, Marion County, the Owens Bottle & Machine Co. has drilled a test on the Lawrence Baker farm through the fifth sand to a depth of 2,835 feet. The hole has filled up 60 feet with fluid. It will be shot and tested for gas. On Finches Run, Fairmont district, the same company's test on the Boor-Wise farm is a fair gasser in the gas sand.

In Union district, Harrison County, the Hope Construction & Refining Co. has a small gasser in the Speechley sand and at a test on the Marshall Martin farm. The Manufacturers Light & Heat Co. has drilled down to the fourth sand its test on the James Parrish farm, in Church district, Wetzel County. It is a gasser.

Lincoln County

In Jefferson district, Lincoln County, the Cambridge Gas Co. has completed a gasser in the Berea grit at a test on the Clinton VanGundy farm. In Carroll district, L. R. Sweetland & Co. have completed No. 3 on the Giles Linkhous farm. It is a gasser in the same formation. In McComas district, Cabell County, the Commercial Gas Co. is testing for gas on the I. D. Cutright farm.

In Clay district, Wood County, Dr. Ira Connelly has completed a test on the N. L. Upton farm good for 8 bbls. a day in the salt sand. In Spencer district, Roane County, the Federal Oil & Gas Co. has a duster in the Cow Run sand at No. 38 on the Provident Mining Co.'s tract. No. 39 is rigging up.

Doddridge County

On Buckeye Run, Grant district, Doddridge County, W. D. Gribble has completed in the Squaw sand a test on the Alexander Stuttler farm. It is a light gasser. On the same stream and same district, the Barbour County Gas Co. has completed a test on the William Ford farm. It is dry in the Gordon sand and abandoned.

In Central district, Doddridge County, Nay & Kintzer have drilled their second test on the F. W. Waldo farm into the Maxon sand. It is located 600 feet west of the first test on this farm and is a gasser good for 1,000,000 feet. In the same district, the Hope Construction & Refining Co. has a gasser in the Big Injun sand on the Harvey Smith farm. In New Milton district, the Murphy Oil Co. has a rig up on the Edward Maxwell farm. In New Milton district, the Manufacturers Light & Heat Co. is drilling its test on the Henry Ahouse farm from the Big Injun to the Gordon sand.

In Sheridan district, Calhoun County, the Great Elk Oil Co. has completed No. 26 on the Samuel Bachman farm. It is a gasser in the Big Injun sand. In Murphy district, Ritchie County, Pope Brothers' No. 7 on the J. H. Gamble farm is a gasser in the Big Injun sand. In the same district, the Hope Construction & Refining Co. has a Maxon sand gasser at a test on the Neil Bradley farm.

In Mannington district, Marion County, Jesse Mason has drilled his test on the D. F. Yost farm and is a gasser at a total depth of 3,208 feet. In the same district, C. A. Snodgrass is fishing at 2,978 feet on the Absolam Holbert farm.

Calhoun County

In Lee district, Calhoun County, Martin Crawley has completed a test on the John Slider farm. It is a gasser in the Big Injun sand. In Reedy district, Roane

(Continued on Page 329)

DEEP TEST IN SANDUSKY COUNTY, OHIO, WILL BE SENT AS FAR AS POSSIBLE

By Whit
Staff Correspondent, Central West Fields

FINDLAY, Ohio, June 11.—Little was accomplished during the week in any portion of the Central West Field, due to the high winds and downpour of rain, swelling the streams and making the ground off macadamized highways almost impassable, especially on leases, where rigs were to be shifted for the starting of new wells. The old Lima Field of northwestern Ohio reported but two completions, and Central Ohio three, both Indiana and Illinois failing to bring in or report a single completion. This is something out of the ordinary for these fields as they usually show a much larger number of new wells.

Very little warm weather has shown up so far this season. Operators are lying very quiet, figuring there is plenty of crude above ground and that further drilling can be held off until conditions improve. The producing wells are being well taken care of regardless of the fact that they are nothing but strippers and have been for years back, but they are well worth the pumping, as they have paid for themselves many times over and with only the cost of pumping and small repairs it is like finding that much money.

Lima Field

Wood and Hancock Counties were the only parts of the old Lima Field of northwestern Ohio that reported any completions and had a combined production of only 18 bbls. The season has been one of the worst experienced in the Lima Field since it was opened in 1884.

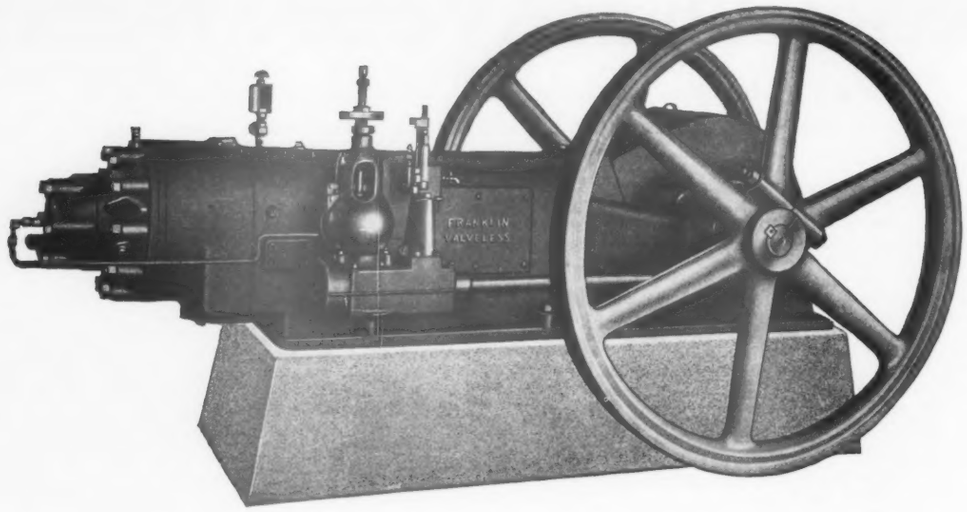
In the McComb district, in Pleasants Township, Hancock County, northwest of Findlay, the Eastern Oil Co.'s No. 3, in the northeast corner of the Sarah Rader farm, in the northwest quarter of Section 14, topped the Trenton at 1,377 feet and at 38 feet in the sand secured a 15-bbl. initial producer, which is a very good well for that part of the country. The Bath Township Oil Co. is about due in with its No. 6 on the Cains & Henry farm, same section.

The other completion was the Oko Oil & Gas Co.'s No. 12 well, 850 feet from the north line and 1,450 feet from the east line of the George Deverna farm, in the southeast quarter of Section 29, Perrysburg Township, Wood County, in the Colt Pool. Sand was found at 1.2 feet and drilled 47 feet in the Trenton, the initial production being reported at 3 bbls. This pool is east of the Dixie Highway between Perrysburg and Bowling Green.

The deep test of the Ohio Oil Co., on the William H. Bruns farm, Section 9, Woodville Township, Sandusky County, between Toledo and Gibsonburg, has reached a depth close to 4,000 feet and will be sent as far as possible. No record of the hole has been announced, but will apparently be given when the drill stops as it is a very important venture and the idea is to test out any lower formations that can be found below the Trenton Rock. The well is located in what was very good producing territory from the upper part of the Trenton but has been pretty well drained from that formation during the past 30 years. The Elmore Field, to the east of Woodville and in Harris Township, Ottawa County, which has had a considerable amount of drilling operations until recent weeks, fails to show one well under way at this time.

In the Tiffin Field, in Clinton Township, Seneca County, Shaul & Geiger are

(Continued on Page 390)



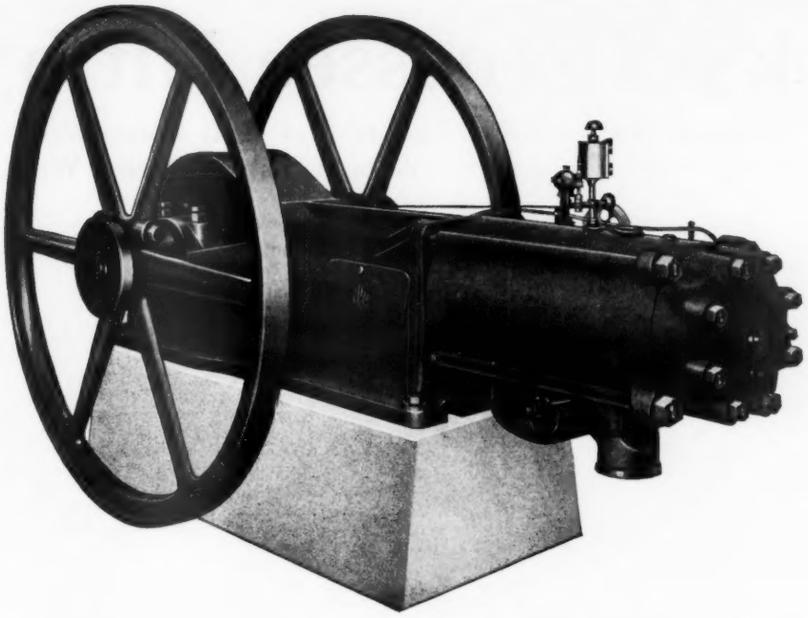
THE FRANKLIN
Oil Pumping Engine

HERE is the power plant that has the fewest possible number of parts to require attention, adjustment, repairs or replacement. After you've finished drilling, move in one of the Franklin Oil Pumping Engines. Any user will tell you that it can be operated at an extremely low fuel, water and lubricating cost.

These pumpers come in 30-40-50 and 75 Horse Power. Can be equipped with Reverse Motor and one way clutch.

THE FRANKLIN VALVELESS
ENGINE COMPANY
Franklin, Penna.

FRANKLIN VALVE



THE FRANKLIN
Gas Pumping Engine

AFTER you've finished making hole, move your Drilling Engine to the next job and hook up a Franklin Gas Pumping Engine. Interchangeable on the same block without shifting a single bolt. These engines can show you a power, speed and flexibility almost unbelievable.

Say good-bye to the old "biler" and learn what real economy and freedom from trouble is like. Ask any Franklin user!

Distributed By
Oil Well Supply Company
Through its 100 Branches

LESS ENGINES

Kentucky-Tennessee Hit by Rains

Ambrose Pool in Ohio County Has Best Completions.
Lecta Pool Is Most Active Area in District During Week

By Whit
Staff Correspondent, Kentucky-Tennessee

LEXINGTON, Ky., June 13.—Kentucky and Tennessee were hard hit by heavy winds and rains that put low grounds far under water. While the western part of the State suffered heavy loss, it did not compare with the damage done in the central and eastern portion. The Cumberland River at Gainesboro, Tenn., after a steady three days' rain put the river to a 30-foot stage, flooding all bottom lands, while the Big Sandy Valley, in the extreme eastern portion the Big Sandy, Levisa, Blaine and other rivers overflowed filling up the gaps through the hills, making it impossible to get over the oil fields. In Cumberland, Monroe and Clinton Counties in the central portion, the Cumberland River and its many tributaries are at such a stage that it is impossible to get anywhere, in fact the population appears to be shut in from the outside world. The past few days the water receded to some extent, leaving the lands in a devastated state. The damages to Kentucky and Tennessee run into the millions, according to advice from many parts of the two states. Oil field work is shut down to a large extent in both states.

The best completion in the Kentucky area for the week was made in the Ambrose Pool, in Ohio County, being No. 8 on the W. Scott Ambrose farm, which showed an initial of 110 bbls. Pipe line gaugers are having a hard time getting to the farm tanks to run the crude in all sections, and lines that are above ground have been damaged by timber floating downstream where some of the lines cross the smaller streams and also in the valleys between the hills.

Seven counties in Kentucky are represented in the completed work for the past several days, or since the previous report from the field.

Week's Work

A summary of the week's work in the Kentucky Fields show 21 completions, 15 producers with an initial production of 406 bbls., 6 dry holes and no gas wells. Compared with the previous week there were 8 less completions, 3 less producers, 585 bbls. less production, 2 less dry holes and 3 less gas wells. These wells were distributed by counties and districts as follows:

County—	Comp.	Wells	Prod.	Dry	Gas
Barren	7	6	118	1	0
Ohio	6	4	260	2	0
Daviess	3	1	12	2	0
Carter	2	2	5	0	0
Warren	1	1	10	0	0
Allen	1	1	1	0	0
Knox	1	0	0	1	0
Total	21	15	406	6	0
Last week	29	18	991	8	3
Difference	8	3	585	2	3

Oil Runs for May

The three pipe lines making reports from the Kentucky-Tennessee fields are the Cumberland Pipe Line Co., handling crude from the eastern half of Kentucky; the Illinois Pipe Line Co., in the western division; and the Paragon Development Co. in Cumberland-Monroe-Clifton and Barren Counties, Kentucky, and Clay and Pickett Counties in Tennessee, which does not include the crude handled by the Stoll Oil & Refining Co. in Barren County. In the Kentucky end of the field, the three companies handled a total of 426,372 26 bbls. from Kentucky, and the Paragon Development Co. handled 3,120.07 bbls. from Tennessee.

The Cumberland Pipe Line Co.'s runs from Kentucky for the four week's up to and including May 28 totaled 242,551.49 bbls. The runs for the week ending May 7, 61,533.22 bbls.; week ending May 14, 60,416.26 bbls.; week ending May 21, 60,010.84 bbls.; week ending May 28, 60,591.17 bbls.

The Illinois Pipe Line Co. handled through its western Kentucky lines a total of 155,538.50 bbls. for May, against 141,253.95 bbls. for April, a gain of 14,284.55 bbls.; and a gain over the March runs of 32,878.48 bbls. The big increase in production came from Ohio and Barren Counties.

The Paragon Development Co. ran during May from the Barren County Field, 18,685.15 bbls., and from Cumberland-Monroe and Clinton Counties, Kentucky, 9,597.12 bbls., a total of 28,282.27 bbls.

The Paragon Development Co. ran during May from the Clay County, Tennessee, fields a total of 2,714.86 bbls.; and from Pickett County, 405.21 bbls.; making this company's total runs from the two states for May of 31,402.34 bbls.; 2,600.08 bbls. more than for April from the two states.

Building Gas Line

Work has started on the new gas line of the Petroleum Exploration Co., which will run from Idamay in Lee-Owsley Counties to Lexington, Ky. It will be 8-inch and will require the laying of 56 miles of this size of pipe. The contract for the laying of the line was let to Sylvester Rich & Co. of Bradford, Pa., and the Petroleum Exploration Co. will furnish the pipe. Under the terms of the contract, Rich & Co. will handle the unloading of the pipe, teaming, hauling, stringing, ditching, laying and backfilling for the new line. The pipe will be shipped at the rate of 2 miles of pipe per day from the mills. It will be unloaded at Cresmont, Idamay, Evelyn, West Irvine, Rice Station, Moberly, Red House, Richmond, Lexington and Brighton, making a total of 291,000 feet. The pipe will be buried to a depth of 30 inches and connected up with Dresser couplings. In putting the line under railroad, highways and river crossings welded pipe will be used as an extra precaution against leakage. The line will cross the Kentucky River at Clays Ferry, 13 miles from Lexington, at which point a loop of two 8-inch lines will be strung 50 feet apart across the river as a protection in case one line is damaged and to prevent an interruption of service, says the Trico News.

Leaving Idamay the survey continues through unusually rough mountainous country, making it impossible to use ditching machines, and all work will be done by hand and no doubt rather slow progress made. After leaving 11 miles of rugged country, the territory is more level and rapid progress can be continued. Unless unforseen delays prevent, it is estimated the gas line will be completed by the coming September. About 300 men will be employed on the job with numerous camps along the right of way.

Eastern Division

Only three wells were reported from the eastern portion of Kentucky, two small producers and one dry hole. Work has been delayed by the weather conditions. The dry hole was drilled by the Petroleum Exploration Co. in its second test on the North Jellico Coal Co.'s property on Indian Creek in Knox County.

In Carter County, on Smokey Hollow, a 3-bbl. showing is reported on the Hugh Owens farm. Robbins and others are reported to have a well showing very light on Rough Camp Creek in the same county.

Western Kentucky

The bulk of development in the western division is centered in Ohio and Barren Counties, although very little has been accomplished during the past several days on account of the stormy season. Warren and Allen Counties are slow in bringing in wells of late and the same can be said of Cumberland, Monroe, Clinton and Daviess Counties, which comprise the bulk of the present territory being developed. W. W. Christian and H. S. Henry, two well-known operators from Allen and Warren Counties, are now in Owensboro, looking over their new and recently purchased holdings in what was formerly known as the Owensboro Field in Hancock, Ohio and Daviess Counties. They purchased and have taken over the properties of the Kentucky Oil Co., which has a number of completed wells in the Pellville Field, and will shortly begin the drilling of new wells in that vicinity, which is along the line of the three counties mentioned.

Ohio County

In the Ambrose Pool, in Ohio County, the Rex-Pyramid Oil Co.'s No. 8 well, 400 feet from the south line and 200 from the west line of the W. Scott Ambrose 78 acres, set a string of 643 feet of casing, found sand from 643 to 681 feet, drilled to a total depth of 691 feet and was shot with 140 quarts. The first 24 hours' production amounted to 110 bbls. No. 9 well, 600 feet from the south line and 200 from the west line of the same farm, cased at 610 feet, found sand from 610 to 660 feet, drilled a pocket 3 feet below the sand and was shot with 120 quarts, resulting in an initial production of 80 bbls. No. 10 well, 200 feet from the north and west lines of the same farm, put in 583 feet of casing, got the sand from 583 to 624 feet, drilled to 634 feet and was shot with 60 quarts, with an initial production of 60 bbls. Other wells will be drilled at once on the same lease.

The Creek Drilling Co. and Hapgood drilled No. 2 well, 525 feet from the north line and 200 from the west line of the Sally Early 112 acres, south of the Weller farm, in the Ambrose Pool, which proved a duster at a depth of 897 feet, or through the Barlow sand.

Wood Oil Co.'s No. 5 on the Deane & Deane farm, in the Collier Pool, to the northeast of the Ambrose Pool, set casing at 470 feet, found sand from 478 to 485 feet and went to a total depth of 498 feet, shooting with 40 quarts and was good for an initial of 10 bbls. Nos. 6 and 7, same farm, are under way.

The Ohio Oil Co. is reported to have drilled a dry hole on the C. W. Reynolds farm, while E. W. Stebbins reports a nice gas showing on the Lyda Carter farm, but will maintain it as a gas well and drill another on the same lease and test out the lower Barlow sand.

James C. Ellis has two wells in the sand on the J. R. Weller 110 acres, in the Ambrose Pool, and the Wood Oil Co.'s No. 6 on the Mary J. Elmore 100 acres is also in the sand, as well as the Ohio Oil Co.'s No. 5 on the Rodney Taylor farm, same pool, and they are all making fine showings.

The Wood Oil Co.'s wildcat on the V. R. Ferguson land, three-fourths of a mile from Sunnydale and approximately 4 miles southeast of the Ambrose Pool, has not yet been given a shot. Manager Curry states that the necessary tankage will be set up before shooting, as it is practically certain the well will flow, as the oil stands close to the top of the hole. This well means the opening of another pool, which is given as the Wood-Sunnydale Pool.

Daviess County

The Petroleum Exploration Co.'s No. 1, in the southwest corner of the F. C.

(Continued on Page 329)

SAGINAW DRILLERS GOING DEEPER; FIELD HAS 196 PRODUCING WELLS

By Whit

SAGINAW, Mich., June 11. — New completions are not as plentiful as they have been in the past, which is due to the fact that quite a number of wells that heretofore were stopped at the Berea sand and new ones are now drilling down for the lower Saginaw sand, regardless of the oil found in the Berea, although if the Saginaw sand or the deeper Dundee formation fails to produce, the wells can be plugged back and the Berea sand produced.

There were up to the first of June approximately 196 producing wells in the Berea Field of Saginaw County, together with several more or less uncertain where there has been a show of oil, but where work has not advanced far enough so it can be determined whether they will make commercial producers. Something like 40 wells are drilling in the present area of the pool. Estimates of men in touch with the output of crude state that the daily production is about 1,455 bbls., or an average of close to 7 bbls. per well figuring that 200 wells are producers, old wells not making anywhere near that amount of crude daily and newer wells doing considerably more.

The well of A. W. Benjamine, trustee on the Benjamine property, corner of Michigan and Irving Avenues, was drilled to the lower Saginaw sand, which was topped at 2,290 feet and the pay in the sand struck at 2,296 feet was drilled to a total depth of 2,310 feet. It was put on the pump Sunday, and produced 60 bbls. This is one of the best finds yet made in that formation. The Ohio Oil Co.'s No. 5 on the Mershon, Eddy-Parker property, failed to find a commercial pay in the Berea sand, but found what is said to be a nice showing in the Saginaw sand, which was found at 2,287 feet, and its value will not be known until entirely completed and put on the pump.

The Saginaw Prospecting Co.'s No. 6 on the Deindorfer Woods, city owned property, in Section 14, Saginaw Township, topped the Berea sand at 1,814 feet and drilled 19 feet in the sand, showing for a 20-bbl. initial production.

Building Refinery

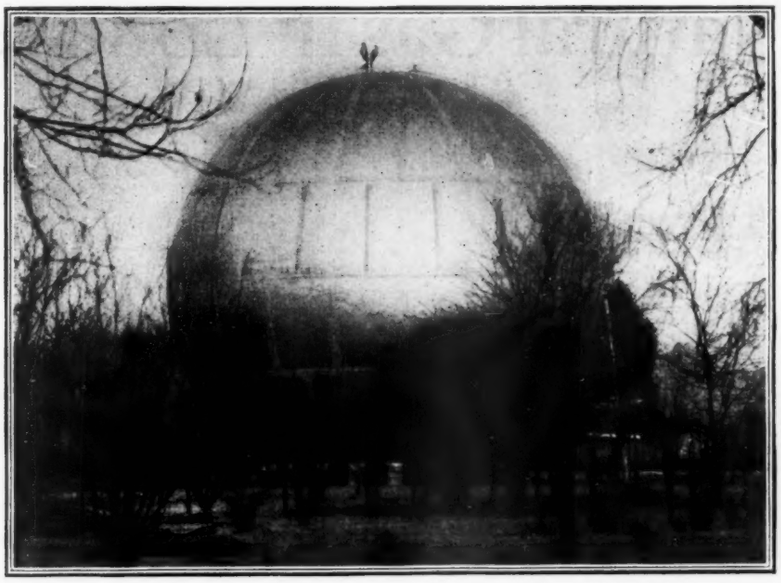
The Standard Oil Co. of Indiana has started work on its refinery to the north of Saginaw and just north of what is called Zilwaumee on the west side of the Saginaw River and west of the Crow Reserve, close to the Michigan Central Railroad. This company has also started laying its lines from the refinery location to the wells in the field and will in a short space of time be ready to run oil into storage at the site of the plant. The construction of the refinery will help to stabilize the field, and is an indication of the confidence of these large operators in its future.

Season's Outlook

Indications at this time are for an interesting summer in the oil business in the Saginaw Field and surroundings. Things that are already under way and plans so far only hinted at assure that and carry more than a suggestion that

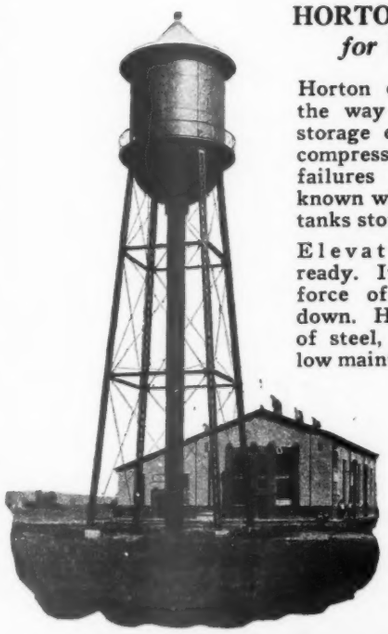
(Continued on Page 337)

The "Natural" Gas Holder



THE Hortonsphere offers an economical type of holder for gas under pressure. It is a simple spherical tank, the natural shape for resisting fluid pressure, with no moving parts and no water, requires no attendance and is easily maintained. It can be located anywhere, even in the residential districts of cities. It is available in a variety of standard sizes and the cost per cubic foot of storage is practically the same for either large or small units.

The Hortonsphere is in wide use in the artificial gas field and offers important advantages to natural gas companies. For example, its use for storage at towns along a natural gas transmission line should make possible a reduction in the size of mains. On some properties, the diminishing supply of natural gas makes it necessary to blend with artificial gas for which the Hortonsphere is ideally suited.



HORTON *Elevated Tanks for Water Storage*

Horton elevated tanks point the way to economy in the storage of cooling water at compressor stations. Water failures are practically unknown when these dependable tanks store your supply.

Elevated water is always ready. It requires only the force of gravity to bring it down. Horton Tanks are built of steel, for permanence and low maintenance.

A Complete Line of Horton Products

Ask for literature on the Horton products—Hortonspheres for pressure storage of gas or gasoline, oil storage tanks, rundown tanks, umbrella roof tanks, Wiggins Roofs for stopping evaporation and fire hazard on oil storage and working tanks, elevated tanks for water supply and miscellaneous steel plate construction.

CHICAGO BRIDGE & IRON WORKS

CHICAGO—2128 Old Colony Bldg. DALLAS—1641 Dallas Nat'l Bank Bldg.
NEW YORK—3147 Hudson Terminal Bldg. ATLANTA—1054 Healey Bldg.
CLEVELAND—2204 Union Trust Bldg. SAN FRANCISCO—1054 Rialto Bldg.
HAVANA, CUBA—Apartado 2507

HORTON TANKS

O&GJ 6-16 Gray

Natural Gas in Louisiana and Arkansas

Historical Development of Various Fields Outlined Together With Formations and Structural Relations

By A. F. Crider
Dixie Oil Co., Shreveport, La.

The map prepared by Mr. Crider to go with this article, is published on page G-71 of the insert in this issue.

It has not been possible to obtain charts and decline curves of the various gas fields of the area under discussion, and consequently no attempt will be made to estimate the withdrawals and the future gas reserves of this area. No complete data are available on any of the fields. This paper will, therefore, be confined to a general discussion of the historical develepoment of the fields, and the formations from which the gas originates, and their structural relations, which caused the accumulation in the sands; also a map showing the location of the fields and the gas lines serving the region.

The development of the gas industry in the area under discussion began in 1905 when the first commercial oil and gas well was completed in the Mooringsport, La., district.

In the early development of the Caddo Field, no especial effort was made to conserve the gas, which was permitted to waste into the air and to flow the oil wells. On May 24, 1906, gas was piped into Shreveport from the Gilbert well, near Caddo City, by the Citizens Oil & Pipe Line Co., with one 6-inch line serving the city.

In the Caddo Field, which later became the largest oil field in the South, many of the original wells were completed as big gassers ranging up to 70,00,000 cubic feet or greater. In a few days or weeks, the gas in many of the wells decreased and the oil increased. It was this district that produced some of the largest oil wells of the South. Fifteen to thirty-thousand barrel producers were not uncommon.

The gas from the Hosston Field came from the Nacatoch sand at a depth of around 750 feet. Poor conservation measures soon exhausted the field.

Following on the heels of the Caddo development was the Shreveport gas field, which covered two or three townships lying just south and west of the city of Shreveport. The well produced gas from the Nacatoch and from the Woodbine horizons. The Shreveport gas field was developed in search of oil, with the usual wasteful results, as far as the gas was concerned. Even with the wasteful methods, there was always a sufficient amount of gas for the city, which, at that time, had very few factories to use gas.

The Shreveport and the Caddo gas fields soon began to fail and a realization of this fact brought to the attention of keen-sighted business men the necessity of an adequate supply of gas for the future, as well as for the present needs of the city.

Elm Grove, Bethany, Cotton Valley, Sarepta, Waskom and Pine Island deep sand fields were later developed to supply the ever-increasing demands of the rapidly growing city of Shreveport and neighboring cities.

Gas from the above mentioned fields is piped as far north as Little Rock, Ark., and as far south as Beaumont, Tex., on the south. A line to Dallas, Tex., is now under construction.

The Monroe gas field, which holds the distinction of being the largest gas field in the world, has not had the accessibility of an adequate domestic and manufacturing market at hand, and since the gas there is well suited for the manufacture of carbon black, it has largely been used for that purpose. Eighty per cent of the carbon black manufactured in the United States comes from the Monroe gas field.

Recently, a gas line has been built from the Monroe gas field to Alexandria and to Baton Rouge, supplying gas to drilling rigs and pumping machinery in the Urania oil field, and to the big Standard Oil Co. of Louisiana's refinery and the Pan-American refinery at Baton Rouge and Destrahan.

El Dorado and Camden, Ark., are supplied with gas from the nearby gas wells, but up to the present there has been no strictly gas fields in southern Arkansas. All of the gas produced there is associated with oil.

Stratigraphy

Petroleum or natural gas is one of the hydrocarbons which has been developed in Nature's laboratory and much of the secrecy attending its origin and development is still known only to Nature's Great Chemist. To the ordinary uninformed layman, gas is a pent up latent force stored away in the unknown and invisible bowe's of the earth. The geologist, with his powers of observation, and with the aid of chemistry, physics and other applied branches of science, working hand in hand with the drillers, have wrested from nature much of the secrecy of the origin of gas and the areas favorable for its accumulation. Thousands of feet of the earth's crust are barren of hydrocarbons in any form. Through a process of elimination, these formations are disregarded in the search for oil and gas.

In the area under discussion, more than 9,000 feet of sediments have been penetrated by the drill. Of this amount, less than 1 per cent carries gas and oil in commercial quantities. In no one place, where wells have been drilled, have all of these formations been found to be present. In any area where wildcat drilling is done, a careful study of the formations is necessary to guard against failure. Where rotary drilling is in use, gas sands may be mudded off, or the drill may stop a few feet short of a formation that carries oil or gas. Below is given a columnar section of the formations of northern Louisiana and southern Arkansas. The youngest formation is shown at the top and ranges in age downward, with the oldest at the bottom.

Geologic Section of Northern Louisiana and Southern Arkansas

	Feet
Recent.	
Tertiary:	
Eocene:	
Jackson	500 + —
Claiborne:	
Cockfield	400 + —
St. Maurice	100–200
Sparta sand	400–500
Cane River	250 + —
Wilcox formation (oil in upper part)	200–2 000
Midway formation	400 + —
Cretaceous:	
Upper Cretaceous:	
Navarro:	
Arkadelphia shale	100 + —
Nacatoch sand (oil and gas)	200–300
Saratoga chalk	100 + —
Marlbrook marl	125 — —
Taylor:	
Annona chalk	100–250
Ozan formation	250 + —
Buckrange (Blossom) sand	0–50
Brownstown marl	100–200
Austin:	
Tokio formation	300 + —
Eagle Ford clay	25–50
Woodbine sand	0–100
Comanchean:	
Washita-Fredricksburg formation	1,000 + —
Glen Rose (oil and gas in upper and lower parts	3,200 + —

Wilcox Formation

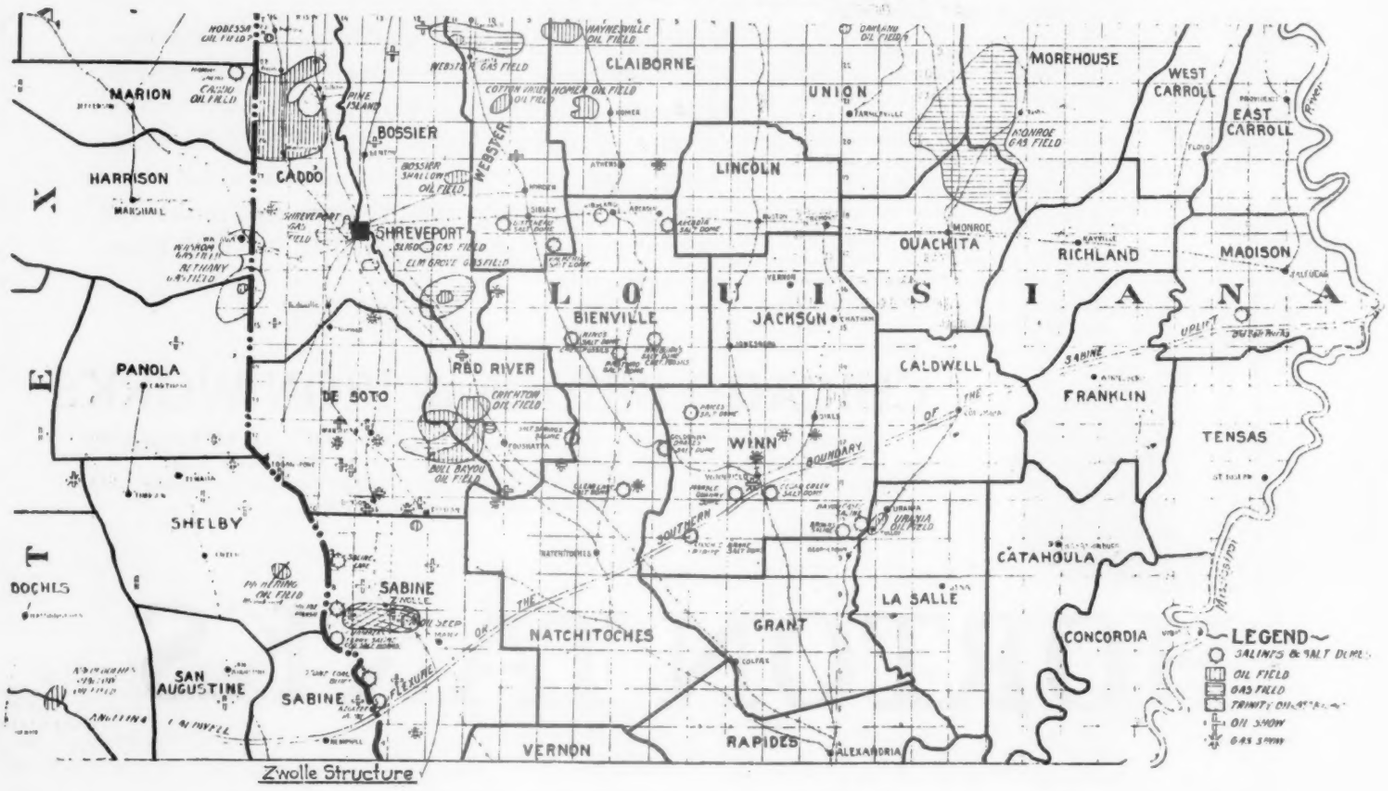
The youngest formation in this area to produce oil and gas is the Wilcox, which is the source of the oil and gas in the Urania Field. At no other locality has the Wilcox been so productive. Shows of oil and gas have been reported in other parts of the area, but it remains to become a producing formation other than in the Urania Field.

Nacatoch Sand

The Nacatoch sand has been the most

(Continued on Page 330)

MAP OF OIL AND GAS FIELDS OF LOUISIANA



No extravagant claims

Performance tells everything

Axelson Machine Company
Los Angeles, Tulsa, St. Louis, New York City
Mid-Continent Distributors—Frick-Reid Supply Company
Eastern Distributors—Frick & Lindsay Company

AXELSON

Liner Pumps

Natural Gas Developments

GAS AND OIL LINES BEING LAID IN TEXAS

HOUSTON, Tex., June 11.—The Houston Pipe Line Co. has laid about 20 miles of the 35-mile 16-inch line connecting Texas City on Galveston Bay with its main line at Alvin. The company will be supplying industries at Texas City within 30 days.

The same company is laying 20 miles of line, skirting the city limits on the north to furnish gas to suburbs, following the rejection by the Houston city commissioners of the company's offer to furnish gas for domestic consumption at 65 cents per 1,000 feet for a period of 10 years. The commissioners granted permission to the Houston Fuel & Gas Co., a competitor, to increase domestic rates from 65 to 80 cents per 1,000 feet.

The Houston Gulf Gas Co. is laying 35 miles of 12-inch line from the Refugio gas fields to the White Point district, across the Neuces Bay from Corpus Christi.

The Gulf Pipe Line Co. is laying a 10-inch pipe line from Midland in the West Texas section to Ranger. The trunk lines from Ranger to Lufkin will be looped. The company's lines from Oklahoma, Central Texas, the Panhandle and North Louisiana and Arkansas converge at Lufkin. At present the company has six 8-inch lines from Lufkin to its refinery at Port Arthur and is preparing to lay the seventh.

The Humble Pipe Line Co. has crews stringing pipe for its 10-inch line from Crane-Upton-Reagan-Pecos Counties to the Gulf of Mexico at Ingleside, near Corpus Christi. The west half of this line penetrates a hill country, sparsely settled and the pipe will be hauled long distances from the railroads to the right of way. It will cause old timers to recall laying lines in western Pennsylvania and West Virginia.

Ingleside is the terminus of the line from the Mirando-Laredo Fields. The crude is shipped from there in barges and small tankers to the Baytown refinery and Texas City terminal.

USE FOR WASTE GAS IN SOUTHERN ALBERTA

CHATHAM, Ontario, June 11.—International Utilities Corp., through its Canadian Western Natural Gas, Light, Heat & Power Co. of Calgary, has made a further proposal to the city of Lethbridge, Alberta, for taking over the Lethbridge power plant.

Under the new proposal, which is tentative, the International Utilities Corp. will assume and pay each year all outstanding debenture charges of the electric light and power plant and street railway; will pay the city in cash the estimated amount of net surplus these properties will earn in the next 18 years, namely $250,000; will install a new unit immediately and further units as required; will operate the street railway or buses; will pay taxes on a fixed assessment of $400,000; will guarantee that the rates recently reduced will not be increased; and if at any time power is offered at a cheaper rate than the company can generate it, will purchase same and give the city consumers the benefit of the reduction. The proposition is understood to foreshadow the extensive use for power production of waste gas now available in southern Alberta.

AMARILLO GAS GROWTH

AMARILLO, Tex., June 11.—Rapid increase in business has forced the Amarillo Gas Co. of Amarillo, Tex., to enlarge its quarters. An addition is being made to the company's building on East Third Street.

MORE CARBON BLACK PRODUCED FROM LESS GAS IN PAST YEAR

The production of carbon black from natural gas in 1926 was 180,576,176 pounds, valued at the plants at $9,939,221, according to G. R. Hopkins of the United States Bureau of Mines, Department. This represents an increase in production over 1925 of 3,158,798 pounds, or 2 per cent, which was, however, insufficient to eclipse the record figure of 186,872,034 pounds established in 1924. Stocks at the plants December 31, 1926, amounted to 108,378,101 pounds, an increase of 12,354,653 pounds, or 13 per cent, over the preceding year. Losses at the plants in 1926 totaled a little over 700,000 pounds, or about half what they were in 1925.

The production minus the addition to stocks and the losses gives total deliveries or sales for 1926 as 167,504,710 pounds, as compared with 175,631,326 pounds in 1925, a decrease of 8,126,616 pounds, or 5 per cent. This is the first time since carbon black statistics have been compiled that total sales have shown a decrease.

Distribution in Industry

The distribution of carbon black deliveries among industries in 1925, as determined by a survey only recently completed, was as follows:

	Pounds	Per cent
Rubber	86,329,000	49.2
Export	43,183,000	24.6
Ink	22,389,000	12.7
Paint	11,757,000	6.7
Miscellaneous	11,973,000	6.8
	175,631,000	100.0

Though similar data for 1926 are not available, except for exports, it is probable that the amounts used in the ink, paint and miscellaneous trades were practically unchanged, the major portion of the decline in total sales being chargeable to exports and to the big consumer, the rubber industry.

The total value at the plants of the carbon black production in 1926 was approximately $10,000,000, or an average of 5.5 cents per pound. This represents an increase of 0.1 cent over the low point of 1925, but is still considerably below the average for the five-year period, 1919-1923. The decrease in average value in 1925 in the face of greatly increased demand and the increase in average value in 1926 in the face of decreased demand were surprising.

Technical advances and the willingness of the carbon black manufacturers to co-operate in the interest of conservation enabled the industry to produce more carbon black from less gas in 1926. The estimated quantity of natural gas used in 1926 to produce the 180,576,176 pounds of carbon black was 130,321,000,000 cubic feet. This indicates an average yield of 1.4 pounds per 1,000 cubic feet of gas, an increase of 0.1 pound over 1925 and the highest yield ever recorded.

Louisiana Leads

Louisiana remained the outstanding producing State, its output in 1926 of over 130,000,000 pounds comprising 72 per cent of the total for the country. West Virginia produced 3,804,586 pounds of carbon black in 1926, a decline of 7,043,208 pounds, or 65 per cent, from 1925. This State, once the leader in the industry, is now producing only 15 per cent of its output of six years ago and only 2 per cent of the output of the country. Carbon black manufacture at present prices is dependent on cheap gas, of which there is little left in West Virginia. Texas showed the greatest gain in production of any of the states, its output amounting to 36,328,052 pounds as against 26,219,510 pounds in 1925, a gain of 39 per cent. This material increase more than compensated for the decline in West Virginia and Kentucky. Three new plants began operations in Texas in 1926, two of them in Stephens County and one in Hutchinson County. The latter was the first carbon black plant to enter the great Amarillo gas field, though many have been projected.

The channel process remained by far the most important method of manufacturing carbon black, producing 152,300,410 pounds in 1926, compared with 28,275,766 pounds by the other processes.

Exports of carbon black in 1926 amounted to 39,210,389 pounds, compared with 43,182,635 pounds in 1925. The 1926, exports had an average value of 9.2 cents, compared with 8.2 cents in 1925. The United Kingdom was our leading carbon black customer in 1926, followed in order by France, Canada and Germany. Of these four countries, France showed the greatest increase over 1925.

MAGNOLIA GAS COMPANY EXTENDING ITS LINES

HOUSTON, Tex., June 11.—The Magnolia Gas Co. has completed welding its gas pipe line from northeast Texas into Dallas, and gas will be turned into the Dallas mains about June 15.

Since the completion of the Latex line to Dallas the engineers have moved back to East Texas and a line is now being surveyed southward from Kirbyville, the announcement also said.

The Magnolia, in addition to supplying the city of Beaumont and the Magnolia refinery there, is now supplying The Texas Company refinery and the city of Port Arthur.

In addition to doubling its line into Beaumont and Port Arthur, the Magnolia, it is currently reported, will extend a line from Port Arthur to Houston, giving the latter three natural gas pipe lines.

GAS FOR OLNEY

OLNEY, Tex., June 13. — The Olney city council granted a franchise to the Upham Gas Co. and signed a contract with that company which provides that Olney shall be supplied with gas by October 1, 1927.

The franchise provides that the Upham Gas Co. shall begin construction of its lines into the city within 30 days from date and that it shall complete same by September 15. A maximum rate for residential connections will be 75 cents per 1,000 feet for the first 25,000 and then on a graduating scale down to 20 cents per 1,000 for all over 1,000,000. Commercial rates specify 50 cents per 1,000 for the first 100,000, with a graduating scale down to 22 cents. Industrial gas will be furnished at the same rate as Wichita Falls, 17 to 11 cents. The gas will come from the Panhandle fields through the Upham lines, completed a few months ago.

GAS RATE INCREASE

LOS ANGELES, Calif., June 11.—The State Railroad Commission has granted the Southern Counties Gas Co. a general increase in its rates in the San Pedro district, including Wilmington, Seal Beach and adjacent territory, exclusive of Long Beach. The new rates will be 98 cents per 1,000 feet for the first 4,000 feet; 85 cents per 1,000 for the next 11,000 feet; 78 cents for the next 25,000 feet, and 72 cents for all gas used over 40,000 feet. The corresponding old rates were 85 cents, 75 cents, 70 cents and a 60-cent rate for a block not exactly corresponding to the new block above 40,000 feet.

POULTRY BROODING WITH NATURAL GAS

CHATHAM, Ontario, June 13.—A recent published statement with reference to the brooding of poultry by natural gas in Ontario indicates a further use for natural gas. The statement says in part:

"Brooding by natural gas costs less than half what it does by coal or oil, and requires practically no labor in the operation of the stove. It enables the attendant to maintain an even heat, which can only be secured when coal is the fuel with a good deal of care, day or night. There are no ashes to shake down and remove, simply the turning of a tap to raise or lower the heat. The automatic draft regulators on coal-burning stoves help to maintain an even temperature under the hovers if the weather conditions are calm; but if it be blustery and windy, and particularly if the conditions change from one to the other during the night, it is quite another question to keep the chicks comfortable.

"There is none of this danger when heating by natural gas. Changing weather conditions have no influence on the temperature under the hover. With an even heat the chicks can be raised much better than in a varying temperature. In the counties along the Lake Erie front, brooding is done largely by natural gas, efficiently and at low cost. Arthur Panter, vice president of the Ontario Goat Association, has brooded 1,500 chicks for six weeks at Simcoe, in Norfolk County, using four brooder stoves. This has cost him, including the heating of his home and cooking for his family, a little less than $30. A stove will consume about a ton of coal a month, so that his bill for fuel for the brooder, if coal had been used, would have been about $60, or double what it costs for brooding and household use of natural gas."

CANADIAN WESTERN GAS ANNOUNCES NEW ISSUE

CHATHAM, Ontario, June 11. — The Canadian Western Natural Gas, Light, Heat & Power Co. of Calgary is making a new issue of $1,700,000 in participating sinking fund preference shares, the offering being at 97 and accrued dividend.

In connection with the offer it is stated that the company produces and distributes natural gas for domestic and industrial purposes to Calgary, Lethbridge, Granum, Claresholm, Okotoks and other municipalities in southern Alberta; serving a population of approximately 85,000. The number of consumers has increased from 5,000 in 1913 to over 15,000. In 1926 gas sales approximated 3,000,000,000 feet, of which more than 85 per cent was purchased by Calgary consumers. Rates are under the jurisdiction of the Alberta Public Utilities Commission. For the three and one-fourth years ending December 31, 1926, net earnings available for preference dividends and income taxes averaged $436,429 a year. Total assets of the company as determined for rate-fixing purposes were $6,192,440. The company has approximately 1,900 shareholders. The company owns 21 producing gas wells chiefly in the Bow Island and Foremost gas fields; and has an agreement with the Royalite Oil Co. to purchase gas from its production in the Turner Valley Field.

ALBERTA GAS EXTENSION

CHATHAM, Ontario, June 11.—It is reported that the Canadian Western Natural Gas, Light, Heat & Power Co. of Calgary is planning to build a 4-mile line to deliver gas from its main line to the town of Stavely. A franchise was granted the company for Stavely some 15 years ago, but it has never been exercised.

MAKING GOOD IN THE FIELD MAKES FRIENDS FOR LA BELLE!

In 1926 One Company Purchased

283 MILES
OF LA BELLE LINE PIPE

and Every Joint O. K.

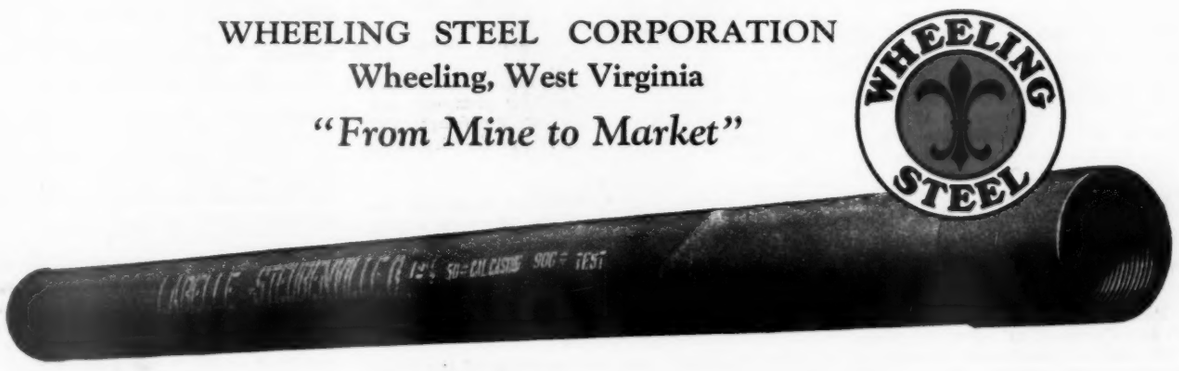
OF itself, this is not significant, yet when it is considered that among a total of 1,494,240 feet of line pipe bought *and installed* within one year by one company, there was not one joint below the customary standard of Wheeling manufacture, it is something worth remembering.

Approximately 74,712 joints, some plain ends, but thousands with threads and couplings, multiply chances for error or slip-ups in inspection, but every joint was La Belle and proved O. K.

"From Mine to Market" manufacture is complete; so is its control, which insures good steel, uniformly fabricated into pipe which serves its purpose whether for tubing, casing or line.

Insist upon La Belle, which is Wheeling-made.

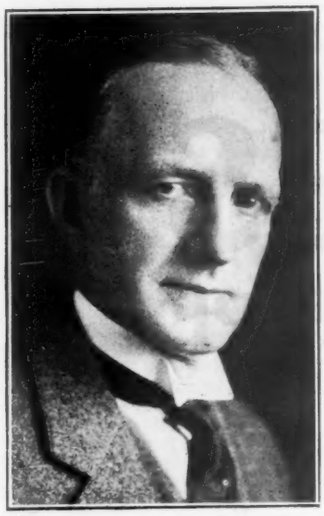
WHEELING STEEL CORPORATION
Wheeling, West Virginia
"From Mine to Market"



LA BELLE

CASING · TUBING · LINE PIPE

MEN KNOWN IN OILDOM



Christy Payne

Christy Payne, president of the Hope Natural Gas Company and of the Peoples Natural Gas Company and elected last week a director of the Standard Oil Company of New Jersey, is an outstanding official in the entire natural gas industry. He is known personally in every section of the United States through the interest he has shown in questions affecting the natural gas industry and through his attendance at meetings devoted to questions of conservation and other kindred subjects.

Mr. Payne was born in Butler, Pa., February 27, 1874, and was educated in the public schools of Titusville, Pa., and at Princeton, from which he was graduated with honors in 1895. He was a member of the Princeton Varsity baseball team for three years, a member of the University Glee Club for three years and was president of his class during his senior year. As honor student at graduation, Mr. Payne recently was awarded the Phi Beta Kappa honor upon the inauguration of the Phi Beta Kappa chapter in Princeton.

Soon after graduation from Princeton, Mr. Payne married Miss Anne Neill of Warren, Pa. They have two children, Martha Payne Emerson and Christy Payne, Jr., and two grandchildren.

Mr. Payne entered the employ of the National Transit Company in 1895, at Oil City, Pa., as bookkeeper. He read law at night under the coaching of the late M. F. Elliott and was admitted to the bar in Venango County, Pennsylvania, in 1898. He moved to Pittsburgh in 1901, entering the employ of the South Penn Oil Company and was admitted to practice in the courts of Allegheny County and the Supreme Court of Pennsylvania in 1902. He was elected secretary and attorney of the Peoples Natural Gas Company in 1903, and to similar offices in the Hope Natural Gas Company and allied gas companies in 1906, also a director of these companies.

In 1920, Mr. Payne was elected president of the Peoples Natural Gas Company, an office previously held by his father, and he transferred his office to New York in October, 1920. He was elected president of the Hope Natural Gas Company in 1926.

Mr. Payne resides at Shippan Point, on Long Island Sound, Stamford, Conn., and East Fifty-fourth Street, New York City. He is a member of the Allegheny Country Club of Sewickley; Mayfield Club of Cleveland; and the Woodway Club of Stamford, Conn.

PERSONAL PARAGRAPHS

Fred Rice, assistant superintendent of the Humble Oil & Refining Company in the Arkansas-North Louisiana district, was in Houston, Tex., the past week at headquarters of the company there.

* * *

Sir George Barstow has been appointed British Government director of the Anglo-Persian Oil Company.

* * *

L. B. Denning, president of the Lone Star Gas Company, Dallas, Tex., is in the East on a business trip.

* * *

Albert Glassell, Shreveport, La., independent oil operator, has returned home following a business trip East.

* * *

L. B. Riddle, vice president of the Shaffer Oil & Refining Company, of Tulsa, Okla., has returned from a trip to New York.

* * *

J. W. Gardner, of the Republic Oil Co. of Pittsburgh, Pa., has been in Shreveport, La., calling on the refining and marketing trade.

* * *

E. H. Edwards, of the E. H. Edwards Company, of San Francisco, Calif., makers of wire rope, spent a few days in Tulsa, Okla., recently.

* * *

O. J. Tuttle, sales manager of the Empire Refineries of Tulsa, Okla., has returned after a 10 days' trip to New York and Washington, D. C.

* * *

Paul Griffin, treasurer of the Oklahoma Pipe Line Company, has completed a trip over the company's lines, and is back at his desk at Muskogee, Okla.

* * *

Martin Van Couvering, a Los Angeles consulting geologist, recently returned from his annual vacation and left immediately for Texas on business.

* * *

C. F. Gustafson, of the Gustafson Oil Company, Chicago, and a marketer of petroleum products, has been in Shreveport, La., visiting refiners there.

* * *

I. L. Grigsby, superintendent of production for Keen & Woolf Oil Company of Shreveport, La., has left that company to engage in business for himself.

* * *

S. P. Tschappat, general manager of the Hercules Tool Company, Tulsa, Okla., is making an extended trip through the East in the interest of his company.

* * *

S. Taguchi and T. Uemura, petroleum engineers for the Nippon Oil Company, Ltd., of Tokyo, Japan, were visitors in Tulsa, Okla., last week. They are making a tour of American oil fields.

* * *

Frank Gardner, chief engineer for the Simms Oil Company, Dallas, Tex., spent several days in Smackover, Ark., recently supervising the test runs of the Simms company's new refinery there.

* * *

John J. Kenney, Pittsburgh, Pa., general superintendent of the Eureka Pipe Line Company, and Miss Blanche Marie Reilley, of Pittsburgh, Pa., were united in marriage at St. Paul's Cathedral, that city.

* * *

Frank Redick, superintendent of shops for the Ohio Oil Company in the Rocky Mountain region, with headquarters at Parkerton, Wyo., expects to leave this month on a trip through the Kansas fields and east into Pennsylvania, and return by the northern route to Parkerton, about the middle of July.

* * *

John Campbell, field representative of the Halliburton Oil Well Testing Company of Duncan, Okla., has returned from a trip to the Everglades of south central Florida, where he tested a well being drilled by the Miami Oil & Natural Gas Company, and has been doing some work in Gulf Coast fields of Texas.

* * *

C. O. Rockwell, general manager of the New York Oil Company's interests in Wyoming, has resigned his position with that company to take a similar office with the Rio Grande Valley Gas Company at Brownsville, Tex. Mr. Rockwell came to Casper, Wyo., in 1920, as a gas engineer with the Hope Engineering Company. His knowledge soon brought him to the attention of the New York Oil Company officials and the firm secured his services from the Hope Engineering Company.

T. J. Newland, representative of the Transcontinental Oil Company in the North Louisiana-Arkansas district, is back at his office in Shreveport, La., after a two months' vacation at his old home at Robinson, Ill.

* * *

George L. Ratcliffe, manager of the General Petroleum Corporation's gas department and newly elected vice president of the Association of Natural Gasoline Manufacturers, has just returned to Los Angeles, Calif.

* * *

Phil Gardner, former Panhandle scout for the Skelly Oil Company, Tulsa, Okla., has resigned to accept a position in the land department of the Douglas Oil Company. He will be succeeded in the Panhandle by Carl Smith.

* * *

George McQuaid, secretary of the Southwestern Division of the Natural Gas Association of America, has resigned as director of the Texas public service information bureau. He is considering accepting similar work with a large utility company.

* * *

H. R. Leland, of the Leland Truck Equipment Company of Tulsa, Okla., accompanied by Mrs. Leland, sailed recently on the Steamship Lapland from New York and will take a 60 days' trip abroad, visiting England, Ireland, Belgium and France.

* * *

H. B. Burlow, representing Templeton, Kenly Company, manufacturers of Simplex jacks, has returned from a three weeks' trip to South America. Overproduction in Venezuela was causing a temporary curtailment in operations at the time he left.

* * *

Harry Heasley, while on his way from Tulsa, Okla., to his home in Emlenton, Pa., was compelled to stop in Pittsburgh where he underwent an operation for appendicitis and gallstones. The operation was a serious one, but he is reported recovering.

* * *

Charles G. Laskey, president of the Northwest Louisiana Gas Company of Shreveport, La., is in New York City on a two weeks' business trip. While en route he attended the commencement exercises at Notre Dame where his son is a graduate this year.

* * *

Ray F. Hinchey, for the past three years manager of the Okmulgee Gas Company, which was purchased by the Oklahoma Natural Gas Company, has resigned to become gas engineer for the Prairie Oil & Gas Company and will be located at Independence, Kans.

* * *

G. L. Estabrook, of Philadelphia, Pa., president of the Crystal Oil Refining Corporation, of Shreveport, La., was in Shreveport the past week, and, with F. W. Burford, vice president and general manager, inspected improvements under construction at the company's refinery.

* * *

Levi Smith, president of the Big Lake Oil Company, Texon, Tex., has returned from Pittsburgh, Pa., where he attended the annual meeting of stockholders and directors of the Big Lake company and the Plymouth Oil Company. Mr. Smith is vice president of the latter company.

* * *

Luther D. Dimm, manager of the El Segundo refinery of the Standard Oil Company, has just retired from active service after 37 years spent in the employ of this company. A gold watch and chain was presented to Mr. Dimm by H. C. Hanna in behalf of his former coworkers.

* * *

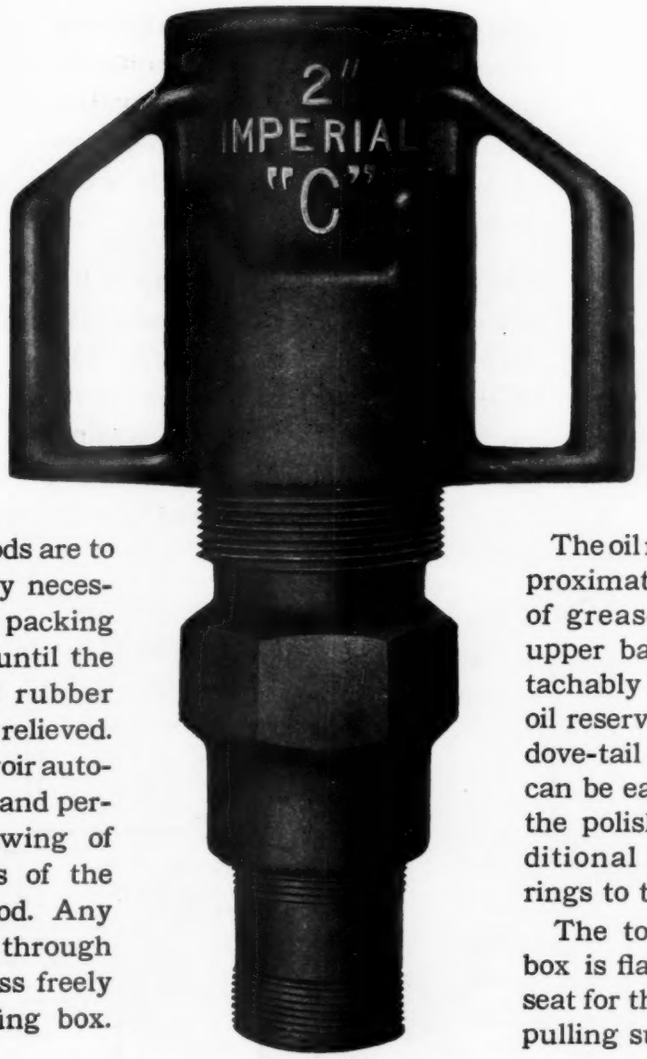
J. C. Lindsay, well-known oil man and former resident of Casper, Wyo., where he was associated with Max W. Ball in the Salt Creek and other fields, is back from Texas looking over the Wyoming country and visiting his many friends. Mr. Lindsay was president of the Wyoming Petroleum Club for one year.

* * *

Frank McCarthy, in charge of all pipe line work in Wyoming for the Producers & Refiners Corporation, and Walter Smythe, George Weller and Bud Green, assistants to Mr. McCarthy, left Parco, Wyo., the past week for Lubbock, Tex., where they will take charge of the Prairie Oil & Gas Company's gas line from Amarillo to Lubbock.

"OILWELL"
IMPERIAL STUFFING BOX
MODEL "C"

The Model "C" Stuffing Box is designed to permit pulling sucker rods and valves (as well as running a sucker rod socket) directly through the box without removing the stuffing box from the tubing. This feature eliminates the use of the sucker rod guide or bell nipple.



"OILWELL" ESTD. 1862. TRADE MARK. (REGISTERED)

"OILWELL" ESTD. 1862. TRADE MARK. (REGISTERED)

When sucker rods are to be pulled, it is only necessary to turn the packing head to the left until the tension on the rubber packing rings is relieved. Then the oil reservoir automatically unlocks and permits the withdrawing of the packing parts of the box on the polish rod. Any tool that will pass through the tubing will pass freely through the stuffing box.

The oil reservoir holds approximately one-half pint of grease or oil, and the upper babbitt gland is detachably connected to the oil reservoir by means of a dove-tail arrangement and can be easily moved up on the polish rod to add additional rubber packing rings to the box.

The top of the stuffing box is flat, offering a solid seat for the elevators when pulling sucker rods.

Patent Pending

Inquire at Any of Our 100 Branches

OIL WELL SUPPLY CO.

NEW YORK—LOS ANGELES—PITTSBURGH, U.S.A.—SAN FRANCISCO—TAMPICO—LONDON

WORLD'S OLDEST AND LARGEST MANUFACTURERS OF OIL FIELD EQUIPMENT

No more delays by sticking

MERCO

IN THE GAS INDUSTRY (and other industries too) the lubricated plug valve was unknown a few years ago.

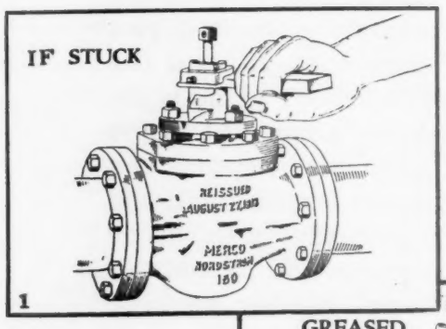
Leaks had to be tolerated. Stuck valves were more the rule than the exception. Hours were frequently lost attempting to open a valve. Breakage took its toll in shut-downs of carrying lines. Hazards were ever present.

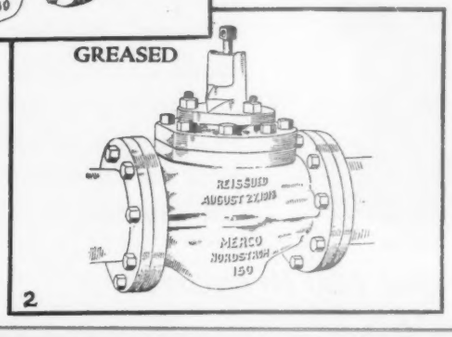
Then Merco Nordstrom Plug Valves were introduced and valve service was revolutionized. The principle of *lubricant under pressure*—to guard the plug against sticking, corroding and preventing leaks—was enthusiastically accepted.

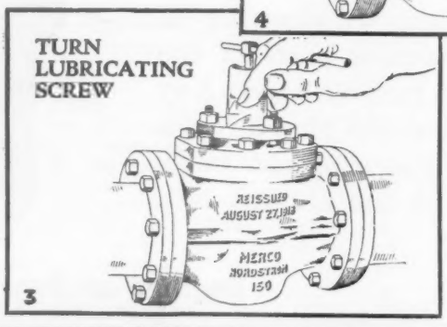
Today these valves are in universal service in gas plants, gasoline plants, oil refineries—everywhere.

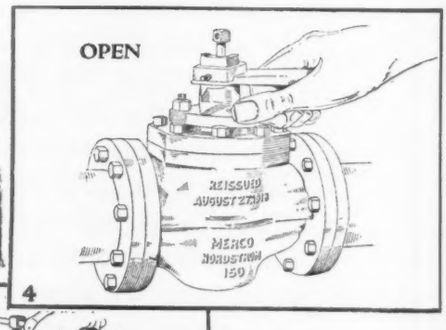
See how quickly valve sticking is eliminated

***Merco Engineers** have compounded special Merco Lubricants for different operating services—to maintain the proper body and film at varying temperatures and in contact with different kinds of gases, acids, liquids and solutions.*



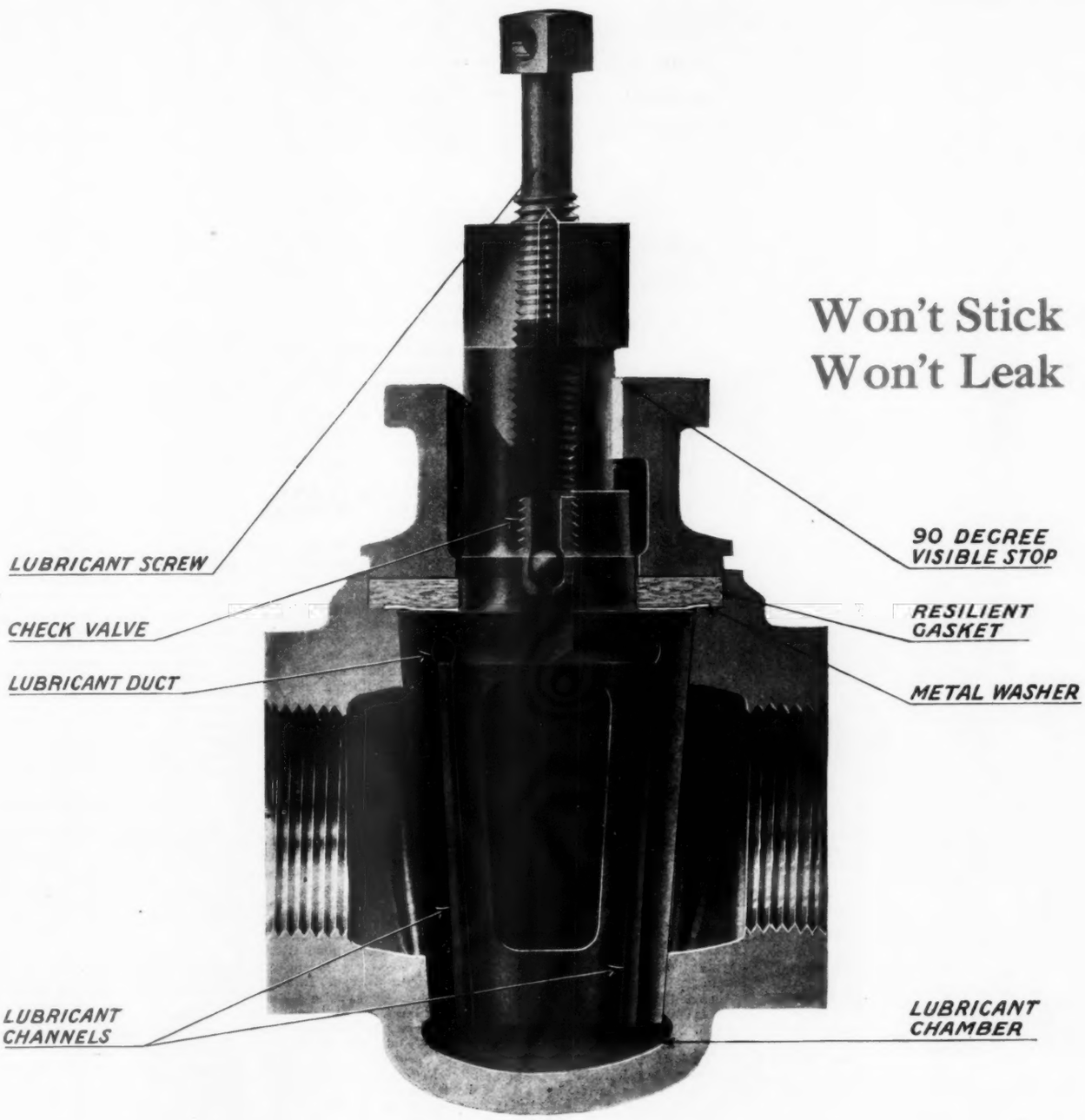






Merco Nordstrom PLUG VALVES

No more wasteful valve leaks



MERCO NORDSTROM VALVE COMPANY

SUBSIDIARY OF THE MERRILL COMPANY

Engineers— MERCO Manufacturers

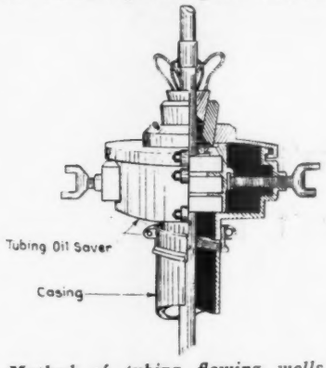
San Francisco 121 Second St. | Chicago Peoples Gas Bldg. | Cleveland 325 Engineers Bldg. | New York 11 W. 42nd St. | Houston 1315 Petroleum Bldg. | New Orleans 1501 Masonic Temple Bldg.

AGENCIES IN PRINCIPAL CITIES. FACTORIES AT OAKLAND, CALIF., AND BELLEVILLE, N. J.

EQUIPMENT AND SUPPLIES

Simple Method Found For Tubing Flowing Wells; Is Successful

The job of running tubing in flowing oil wells where the tubing is open and the oil is free to flow through it is not only messy but dangerous in a busy field, and results in a certain amount of loss depending on the size of the well. Production men for The Texas Company's producing department in the North Central Texas division have devised a simple method for preventing this waste and



Method of tubing flowing wells without loss of oil.

eliminating the fire hazard which has proved successful in every test so far.

The accompanying diagram shows about all there is to this device. A tubing oil saver of standard make, several of which are on the market, is used to eliminate loss of oil between the tubing and the casing. When the tubing is run, a circular piece of ordinary window glass is fitted in the bottom joint between rubber gaskets and held in place by a coupling. It has been found that the glass is strong enough to withstand the pressure in all wells where it has been used so far, and this prevents oil flowing out through the tubing.

After the well is tubed and connected at the top, a small piece of cast iron, or anything that will drill up readily in case it is ever necessary to deepen the hole, is dropped into the tubing and breaks the glass. During the three hours or so in which the well is being tubed, a considerable head is built up, and the surge of oil which follows shattering of the glass assists materially in starting the well to flow.

This device has been used with success on The Texas Company's Fanny Lowe lease in the Fry Pool of Brown County in tubing wells which were flowing steady or by heads from the 1,300-foot sand. Joseph Merkt, superintendent of drilling and production for the company in the North Central Texas division, is given credit for devising it. The practice formerly was to wait until 3 or 4 o'clock in the morning when the wind died down to tube a well on this lease because of the number of shacks, drilling machines, tanks and other things in the vicinity which constituted a fire hazard. This delay of 24 hours or so and the inconvenience of getting the crew out at night are now eliminated.

This idea looks so simple that it may have been used before in other places, but if so the Brown County operators are unaware of it.

FRENCH BUYING MORE BECAUSE OF CURRENCY

Business in France is booming and promises to surpass all records established during 1926, according to J. B. Farwell, foreign manager of the Worthington Pump & Machinery Corp. at Paris, home for a three weeks' conference with L. J. Belnap, president of Worthington.

"One of the most remarkable features of commercial France today," said Mr. Farwell, "is the extraordinary expansion of the buying power of the nation. The days when the average Frenchman hoarded his money are gone. The instability of the franc has made a spender of him.

"Rather than have a sudden fall of the currency catch him with a stocking full of worthless money, the average citizen has turned to buying, exchanging his uncertain francs for solid possessions which do not fluctuate. That is why you see more purchases of automobiles by Frenchmen today than ever before, and this is true, not only of automobiles, but of all things."

CLIMAX ADDS TO SALES FORCE

Two new men have been added to the sales organization of the Climax Engineering Co., Clinton, Iowa. H. P. McCullough will be located at Houston, Tex., with offices at 328 Chronicle Building, while E. H. Crippen will make his headquarters in Fort Worth, Tex., at 4023 West Seventh Street. Mr. McCullough and Mr. Crippen are both experienced in the oil field practice and will be valuable additions to the sales staff. They have received training at the Climax engine factory at Clinton and have a very thorough understanding of the design and operation of Climax oil field units.

The National Supply Companies are exclusive oil field distributors of Climax engines and the new members of the Climax sales force will work with them in the distribution of Climax products.

NEW STEEL BALL FACTORY

The Strom Steel Ball Co., exclusive steel ball manufacturers, announces the full operation of its new factory situated at 1842-50 South Fifty-fourth Avenue, Cicero, Ill., a suburb of Chicago. This plant of the Strom Steel Ball Co. affords an approximate 75 per cent additional manufacturing capacity and represents one of the finest and most modern equipped metal ball factories in the world.

OPENS THIRD WAREHOUSE

The Big Three Welding & Equipment Co. of Fort Worth and Houston, Tex., the Texas and Oklahoma distributor for "Stable-Arc" welders, manufactured by the Lincoln Electric Co., Cleveland, Ohio, announces the opening of its third warehouse branch at No. 1 North Frankfort Street, Tulsa, Okla. Stocks of Lincoln "Stable-Arc" welders and service parts are carried at all three branches.

SHEFFIELD STEEL CHANGES

Sheffield Steel Corp. of Kansas City, Mo., announced the appointment of Ernest Baxter as assistant to the president; J. C. Shepherd is made general manager of sales, and J. W. Anderson is appointed assistant general manager of sales.

OPENS DISTRICT OFFICE

MIDLAND, Tex., June 13. — Union Pipe & Tank Co. has opened district headquarters here with J. E. Gaffney in charge of the district office. The office was established to better serve the fields in Crane, Upton, Winkler, Reagan, Pecos, Glasscock and Howard Counties.

TRADE LITERATURE RECEIVED

The Newark Wire Cloth Co., 351-365 Verona Ave., Newark, N. J., has mailed out its new catalog, No. 26, which supersedes catalog No. 25. The new catalog includes complete information with list prices on double crimped heavy steel wire screens, regular coal screens, steel wire cloth, bran duster grade of cloth, tinned mill screen cloth, brass, copper and bronze wire cloth, phosphor bronze wire cloth, Newark metallic filter cloth, monel metal wire cloth, testing sieves, foundry riddles, dipping baskets, and renewable bottom sieves.

A new edition of J. H. Williams & Co. catalog in pocket-size form has recently been issued, containing much new and unusual information. Of particular interest is the section which has been added showing the complete line of "Superenches" (chrome-molybdenum steel). These are made in five patterns — all guaranteed against breakage.

The April issue of the Rig and Reel Magazine, published by the Parkersburg Rig & Reel Co., Parkersburg, W. Va.

From Smith Welding Equipment Co. of Minneapolis, Minn., a new catalog and price list, giving the details of that company's line of welding and cutting tools.

NEW STEEL TANK PLANT BEING BUILT IN TULSA

All foundations, railroad sidings, etc., are completed and the buildings and machinery are now being erected for the fabricating plant of the Vulcan Steel Tank Corp., a recently organized firm composed of Tulsa business men.

The plant, located on a 5-acre tract, will be of the most modern construction and equipment for the manufacture and erection steel tankage—both for pressure and storage purposes, as well as for light and heavy steel plate work required by the refinery trade. The plant to start will have a capacity to employ 100 men. men.

The Vulcan Steel Tank Corp. will be under the personal direction of James F. McKelvey, who operated the Pioneer Tank & Boiler Co. since 1915, prior to Mr. Farquharson, owner of that business, taking charge two years ago. Since Mr. McKelvey terminated his connections with the latter concern shortly after the first of the present year he has been engaged in the organization and construction of the new plant. Directors and officers of the Vulcan Steel Tank Corp. are James F. McKelvey, president; J. S. Warren, vice president; E. P. Day, secretary; L. N. McKelvey, sales manager, and R. B. Millard.

A part of the same site and trackage facilities will be used by the Southwestern Engineering Corp. for its new plant, fitted specially to serve its Mid-Continent trade. The Southwestern Engineering Corp. is operated by R. B. Millard and associates, with headquarters in the Mayo Building, Tulsa, Okla.

NEW REPRESENTATIVES OF TEXAS STEEL CO.

H. P. Bostaph, sales manager of the Texas Steel Co, recently announced that Paul Reid, formerly assistant auditor of the Houston Oil Co., is now identified with his company as field representative; and that Dan D. E. Hudgings of Shreveport, La., has been appointed district representative for the Texas electric steel sucker rods in that territory. Mr. Bostaph further stated that these appointments were in line with the company's policy for expansion to accommodate the increased demand for electric steel products.

NEW PROCESS FOR PIPE MAKING IS ANNOUNCED

Reports that gained wide circulation in the oil fields of a new process for making pipe and a new mill that would have vast capacity for the production of gas line pipe became a fact with the announcement, on June 15, of Smith-steel gas line pipe by the A. O. Smith Corp., of Milwaukee, Wis. The pipe is announced in sizes of 16 to 22-inch diameter and in uniform lengths of from 10 to 30 feet. The mill will have a capacity of 4½ miles of pipe per day.

Details of the process used are not announced, but it is understood it is based on the same principle of production as the Smithsteel cracking stills and Smithsteel couplings, both products of the A. O. Smith Corp., which announces its new pipe mill embodies most advanced operating and engineering methods.

It is stated that the method makes the production of pipe of uniform wall thicknesses, diameters, and uniform length virtually automatic. According to the reports of the Smith engineers, the new Smithsteel gas line pipe embodies a number of features that will save both time and money in the construction of cross-country pipe lines. Joining, it is remarked, especially, will be simpler, due to the accuracy to which the pipe is made. The pipe is offered in both plain end and plain end bevelled for field couplings or welding. The 30-foot length probably represents the most outstanding contribution of this pipe to gas line engineering. The company states the length will be cut to absolute uniformity and will, of course, require fewer joints.

Another novel feature is that the thickness can be specified by the purchaser for each job. Due to the method of building, it is stated, it is possible to build the walls to a greater degree of thinness. The pipe line builder need specify only the thickness of metal needed, in view of the conditions and pressures under which the pipe line will operate. The pipe will also be produced in any specified length from 10 to 30 feet.

NEW PUMP AND BIT

Two new items of oil field equipment are under experiment at the Joplin, Mo., foundry of the United Iron Works. The first is a new hydraulic oil well pump, invented by a Joplin mining man and financed by an organization called the Hydraulic Deep Well Pump Co. of Joplin.

The other item is a new type of rotary drilling bit invented by C. R. Barry of Fort Smith, Ark., and Oscar Goolsbee of Bryant, Tex.

FORT WORTH BRANCH

The Emsco Derrick & Equipment Co. has opened a branch office in Fort Worth, Tex., with Arthur M. La Mothe in charge. The Fort Worth district will have charge of sales in Oklahoma, Louisiana, Arkansas and all Texas except the Gulf Coast section. The company has a factory in Houston. E. M. Smith, president of the company, has sailed for Europe and will visit the European oil fields.

J. S. MELLON ON TRIP

J. S. Mellon, sales manager of the Dunn Manufacturing Co., Oxnard, Calif., manufacturers of oil well tools and equipment, left early in June for an extended trip through Colorado, Wyoming, Montana and Canada, leaving from the Panhandle of Texas and New Mexico. It has been some time since Mr. Mellon covered this territory and his many friends will welcome his return.

Quickest to Dismantle

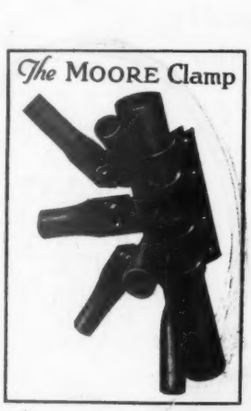
World Wide Service for Twenty Years

Moore
TUBULAR STEEL DERRICKS

A Wrench—Common Labor—A Few Hours

THAT is all you need to dismantle a Moore Tubular Steel Derrick. Simply remove the bolts—only one wrench is required—and lower the parts to the ground. Legs, clamps, girts and braces come apart as easily as they are put together. The derrick acts as its own scaffolding. It's the simplicity of Moore construction that makes it quickest to erect and quickest to dismantle.

The MOORE Clamp



LEE C. MOORE & COMPANY, *Inc.* PITTSBURGH · TULSA

Established 1907

DALLAS, TEXAS HOUSTON, TEXAS WICHITA FALLS, TEXAS BORGER, TEXAS PARKERSBURG, W. VA.
CASPER, WYO. SHREVEPORT, LA. EL DORADO, KAN. EL DORADO, ARK.

COOPER

Should a Gas Company Advertise?

It has been our good fortune to supply the gas engine driven compressors for practically all of the larger natural gas projects during recent years. Among the larger users are Columbia Gas and Electric Co., United Fuel Gas Co., South Penn Oil Co., Hope Natural Gas Co., Ohio Fuel Corporation, Empire Natural Gas Co. and other Cities Service subsidiaries, Magnolia Gas Co., Houston Pipe Line Co., Lone Star Gas Co., Arkansas Natural Gas Co., Midwest Refining Co., Midway Gas Co., Ventura Fuel Co., and Southern Counties Gas Company. The companies which have used the most power and have shown the most rapid growth are the ones that have done the best jobs of selling their service to their ultimate consumers.

An outstanding example of this is the company which is carrying through the huge project described in the Cooper Advertisement on pages G-92 and G-93 (special insert) in this issue.

We believe a continuation on our part of the same policies which have caused Cooper equipment to be used so generally in the past will result in its choice for compressor stations to be built in the future. We are therefore interested in every factor contributing to the growth of the natural gas industry.

One of the greatest of those factors is undoubtedly carefully arranged publicity on the part of the gas companies.

ENGINE BUILDERS FOR NINETY-FOUR YEARS.

THE C. & G. COOPER COMPANY
Mt. Vernon, Ohio

1605 Kirby Bldg. Dallas 604 Kennedy Bldg., Tulsa
649 S. Olive St., Los Angeles

ONCE A COMPANY USES COOPERS THEY SELDOM IF EVER CHANGE

OVERPRODUCTION IS DISCUSSED BY E. W. CLARK

(Continued from Page 38)

problems, to remove obstacles, to modify and ameliorate outworn policies. We will do well to encourage constantly the disposition thus shown.

I do not believe it is too much to hope that a time will come when an industry like ours, confronting the peculiar difficulties that we now face, will be able to lay its troubles frankly and fully, and without fear of unwarranted regulation, before appropriate governmental agencies, and secure measures calculated alike to help us and to promote the true public interest. The men of this industry ought not to be afraid of injunction and prosecution, to attempt to do the things that simple common sense tells us should be done. The moderation and reasonableness of all expressions that have come from the Federal Oil Conservation Board convince me that that board sympath'zes with this view. Whenever we shall have convinced Government of our complete good faith; and whenever Government shall have convinced industry that it wishes to be constructive and helpful.—then, I believe, effective, useful, working co-operations, to the advantage of all concerned, will have been brought in sight. It is up to us to do our part.

Permit me a moment to suggest that the present critical situation in our history is not one to be considered merely in terms of Seminole, Earlsboro, Spindletop, Panhandle, or any other momentarily flush area. I submit that we need at this time to take a world view, to think in terms of a decade or a generation, and not of a few months or a year.

Outlook for Future

Less than 20 years ago Russia produced more petroleum in a year than the United States. With the epoch of turbulence and revolution, Russia sank to unimportance, while the United States rose to dominance. But we know Russia possesses enormous oil resources. We know that the present Russian Government hopes to turn these petroleum resources into financial support for its desperately weakened economic establishment. We may be sure that before many years Russia will somehow become once more a first-class power in petroleum.

Then glance to the south of us, and just over the horizon of the Caribbean we see Venezuela, with a potential production as great as was that of the United States only a few years ago. We recognize the assured possibilities of Colombia. On the other side of the world, in the great Perisian-Mesopotamian area of the Middle East, we find still another factor of potential and enormous competition.

We know that since the war more of governmental and industrial energy and effort has been devoted to seeking out the world's resources of petroleum than to any other field of industrial enterprise. And we may not close our eyes to the fact that this search has so far succeeded as to bring the world's petroleum industries face to face with conditions which certainly dwarf the significance of a few local and temporary phenomena of overproduction here in the United States. This is a situation in which we may well invoke the serious thought and earnest co-operation of both political and industrial statesmanship. It does not concern merely a single American industry; it has vitally to do with every power-making, power-using, power-dependent interest in this Twentieth Century world. It not only deserves to be recognized as of these gigantic proportions, but it demands to be considered and dealt with in the light of such a view as I am here roughly sketching for you.

Conditions Demand Thought

If ever there was a world-wide industrial situation that merited, indeed required, to be dealt with in the broadest and most understanding fashion, it confronts us today. We need, and we are entitled to, the support and assistance of our Government in visualizing and dealing with this world condition. For one, I believe there is vision enough, and liberality enough, among our leaders of national policy and industrial programs, to initiate measures adequate to cope with such a situation. I believe we should take this picture, with its details filled in by men better equipped than I am, to those instrumentalities of Government which have to do with such problems as these. We should bespeak their help, their co-operation, and their authority in dealing with the international phases of these affairs. For one, I do not doubt that the Federal Oil Conservation Board, and the national administration, if this entire condition be frankly and effectively presented, would be ready to join with us in a far-reaching constructive program aiming to avert an economic disaster of international proportions and the gravest character.

The problems involved in making fundamental changes in our present system are innumerable. Present practice bristles with faults and weaknesses. Yet too sudden or too radical departure might mean either exhilaration or financial disaster to your company or mine. The truth is that necessity has forced us to seek knowledge which only scientific investigation and practical research can develop. Without the knowledge of facts, no one can offer any constructive plan with the slightest hope of its adoption either by the oil industry or by the Government.

First, Know the Facts

We should at once proceed co-operatively to do what many of us are, after a fashion and unrelatedly, doing individually. The units of the industry should put into the institute, as a central reservoir, all the known scientific facts about oil production which they have individually developed. And through this medium the whole industry should be correctly informed of the knowledge gained by practical research and experimentation, so that individual units might carry on similar work or adapt their methods to conform to new knowledge.

Candidly, I have no panacea to offer. I have, as you have, many ideas and many opinions. I agree with a lot of oil men and disagree with a lot of others, just as you do. Without adequate knowledge based upon provable facts I cannot translate my opinions and ideas into actualities—nor can you. But I am positive results will be obtained by evolution and never by revolution. The educational program now under way must be continued and expanded as was and is now the case in our standardization work. Gradually as the industry learns the truth, one intelligent step after another will be taken, the results showing with remarkable speed once a start is made.

Need to Save Gas

Personally, I am inclined to think that it may be necessary to recommend that state legislation be had through the medium of a simple bill to prohibit the escape of gas into the air except during drilling, completion and testing of the well. The reason is obvious. The advantages and disadvantages should be discussed and weighed to see if the result would adequately compensate us, as sooner or later the industry may be urged to act in this direction. But this should only be adopted as a last resort after decision is reached that co-operation within the industry in this direction is impossible and hopeless.

Nothing is ever gained by becoming hysterical. At present we all should be calm and keep cool, taking our medicine for whatever economic sins of omission or commission we may have committed, which contributed to make conditions as they are.

In conclusion, I desire to take this opportunity to urge upon the operator and producer in our industry the importance of now adopting the A. P. I. standards. Those who have not already done so, please start immediately by obtaining handbooks of A. P. I. standards and issuing instructions to your staff that they are to be adopted with as little delay as may be consistent with good business. You will be surprised at the slight cost in making the change. We have tried it and know.

AMERICAN PETROLEUM INSTITUTE TO CREATE ACCOUNTING DIVISION

By L. M. Fanning

During the current year many of the major oil companies' financial reports will be based on the standard accounting system thus far developed by the Division of Taxation and Accounting of the American Petroleum Institute, of which M. W. Mattison is director. This applies to balance sheets but all the organizations are rearranging their general accounts to fit the form of balance sheet devised by the general committee on Uniform Methods of Accounting.

Recognized as among the most important co-operative developments in the industry, the movement toward uniformity of accounting methods has attracted attention to problems of accounting peculiar to the business and it is now proposed that a chapter or division of the American Petroleum Institute be organized functioning separately from but under the supervision of the board of directors of the institute. The Committee on Uniform Methods of Oil Accounting has made recommendations to the board to this effect, and has asked opinions on the proposed action from the various oil companies.

The uniform balance sheet was passed by the board of directors at the Tulsa annual meeting last December and in most cases this was too late for the companies to revise their methods so as to put out their financial statements for 1926 under the uniform method. However, starting with the first of the year many companies began converting their systems to the uniform treatment.

The report of the Standard Oil Co. of California for the year 1926 followed the American Petroleum Institute's uniform method as regards the balance sheet. The Gulf Oil Corp. in its statement in connection with the recent $35,000,000 debenture issue followed the A. P. I. method.

In its annual report for 1926, the Standard Oil Co. of New Jersey stated that it had been unable to follow the uniform method because of the shortness of time in which to convert its accounts but that in the future it would do so. The Humble Oil & Refining Co. is now using the A. P. I. methods and among other companies converting are the Sun Oil Co., Union Oil Co. of California and the General Petroleum Corp.

Movement for Separate Chapter

The movement for a separate chapter for financial and accounting in the American Petroleum Institute is in line with the trend in the institute's handling of other technical features of its activities. Membership will be divided according to the specialized activities of those belonging to it and the work and study on the various subjects will be conducted a good deal as has been done in connection with standardization of equipment.

The principal advantage seen in this form of organization is that it dignifies the work and gives it a bigger place in the large movements undertaken co-operatively by the industry. Under the plan the division will have its own officers, consisting of a president and five divisional vice presidents and a divisional secretary. The plan provides for a separate membership, with additional dues of $2.50 a year, this being set up to help take care of costs of printing, etc.

The membership of the division would be open to any one in the industry engaged in financial or accounting work.

Committee's Recommendations

The following recommendations have been made to the board of directors of the American Petroleum Institute by the Committee on Uniform Methods of Oil Accounting:

1. That your board authorize the organization, as a department of the institute of a "Division of Oil Accountants of the American Petroleum Institute," the activities of which shall be devoted to the handling and discussing of the industry's co-operative accounting problems and those of the men engaged in the accounting departments of oil companies.

2. That the Institute's by-laws be changed to provide: (a) that any member who is actively engaged in the accounting department of an oil company, upon payment of an additional fee of $2.50 may be automatically enrolled as an active member of this division, and (b) that such division be given representation upon your board of directors.

3. That it be authorized to have a divisional president, five divisional vice presidents and a divisional secretary, all of whom shall serve without compensation.

4. That the division be authorized to have and elect from its membership a divisional board of directors to be composed of its seven officers, as ex-officio members, and 15 other directors.

5. That the revenue derived from membership fees in this division be credited to the division and that the additional funds, if any, necessary to conduct its activities be a part of the regular institute's budget, all expenditures to be handled in the usual manner required by the by-laws for approval and disbursement of institute funds.

6. That, with the approval of the elective and administrative officers of the institute, the division may from time to time adopt its own rules of procedure and may organize geographical sections with appropriate officers and committees and may hold sectional meetings, if desired.

7. That no action by the board of directors or the members of the division shall be binding upon the institute unless and until it has the customary approval of either the board of directors or the executive committee of the institute, or one or more of its elective executive and administrative officers having authority to give such approval.

8. That the general secretary shall designate a salaried member of the staff of the institute as director of the divisional activities who shall, unless otherwise directed, maintain his headquarters at the general office and who shall supervise and conduct the general detailed work of the division's activities.

KANSAS CITY GAS LINE IS FURTHER DELAYED

KANSAS CITY, Mo., June 11.—The Texas Corp. and the Columbia Carbon Co. will not ask immediately for an industrial gas franchise in Kansas City.

The future course of these interests, which first brought up the prospect of industrial gas here, is a subject for future conference on the part of the higher officials of the two corporations—and these conferences have been delayed at least 30 days by the sudden departure for Europe of Judge Amos L. Beaty, chairman of the board of The Texas Corporation.

"A decision will be made when Judge Beaty returns from his business trip to Europe," Ralph E. Morrison, representative of the two interests, said. "I can say nothing more at this time."

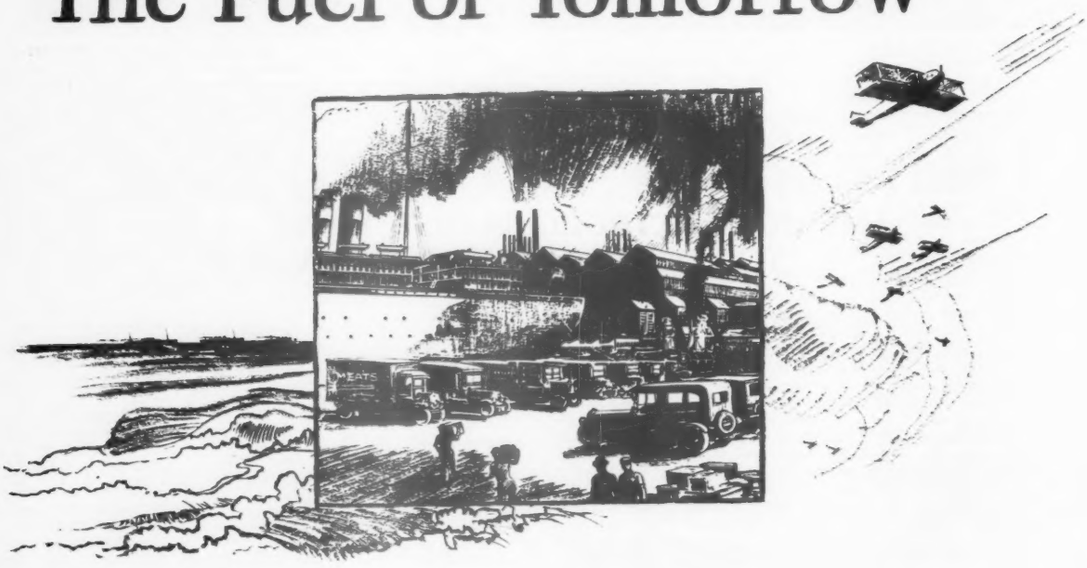
Doubt that The Texas Corporation will have any further proposition to make is sure to arise.

The first proposal of The Texas Corporation-Columbian group three months ago made gas in quantity and price a lively issue in Kansas City.

A committee named by the Chamber of Commerce had several hearings, finally reporting it did not see prospects for the minimum requirement which The Texas Corporation-Columbian group had named for its entrance into this field, 70,000,000 cubic feet a day.

A project other than The Texas Corporation proposal and the Henry L. Doherty counterproposal was brought forward as the Citizens Gas Co. This third group now has pending before the City Council its application for a franchise to distribute industrial gas here.

The Fuel of Tomorrow



its production demands Good Steel !

Certain lines of business can operate more or less successfully with mediocre machinery and tools, but in the oil industry, the chances of success are so limited and the risk so great the use of ordinary tools are anything but economical.

Quality tools are responsible for the vast volume of oil being extracted from the earth today.

Tools made of ASCO STEEL have played an important part in the success of the oil industry because it is good steel—very good steel and through its constant use, breakdowns, delays and failures have been minimized. The assistance of our metallurgists will be rendered without charge.

ASCO STEEL
STANDS SUPREME

THE ANDREWS STEEL CO.
NEWPORT KENTUCKY

DISTRICT OFFICES:
502 Cosden Bldg., Tulsa, Okla.
61 Fremont St., San Francisco, Cal.
724 Kohler St., Los Angeles, Cal.
541 McCormick Bldg., Chicago, Ill.

"A Story of Steel and Oil" is a historical sketch of the petroleum industry. Write for your copy today.

MAGNOLIA LINE HAS MANY NEW FEATURES

(Continued from Page 42)

and schooled in welding and the result was that skilled welders were obtained. However, competent welders are comparatively easy to obtain now and such a school was not necessary when the second line was started.

Welding of the Beaumont line was started June 1, 1924, and completed October 31 but the ditching of the line was not completed until January, 1925. Twenty-foot joints of pipe were used and the line has approximately 60,000 welds in it. When the welding crews were started they were placed over the line at intervals from 30 to 40 miles apart.

To check the welds and to determine if any flaws were going by unnoticed, the line was welded in sections ranging from 2,500 to 5,000 feet in length. Bull plugs were welded on the ends of the sections and 100 pounds of air pressure put on the line with small portable field pumps. While the line was under pressure each weld was hammered and then covered with soap suds to detect any pinhole leaks or other defects. When defects were discovered the weld was cut out and the joints rewelded. However, such instances were infrequent.

Particular interest was taken in the personal element and as each welder completed a weld his number was stamped on the completed weld. In this manner a careless or incompetent welder was quickly detected and discharged.

One of many creek crossings along gas line's right of way.

Each Had Cutting Machine

As a means of determining the character of a weld, each welding crew is equipped with a cutting machine that cuts out a cross section of a weld when one is desired. This machine was an improvement on a cutting machine and the improvement was the design of G. O. Carter, a consulting engineer for the Lindsey company. It resembles a keyway cutter for a shaft and is equipped with two cutting discs which cut a section approximately one-eighth of an inch wide at right angles out of the weld. Such a cross section reveals the penetration of the weld and minute details of the workmanship of the welder.

Six welding crews, consisting of from 24 to 36 welders per crew, did all of the welding. A crew of from 24 to 28 welders will weld from 200 to 300 joints per eight-hour day during fair weather and in reasonably level country. During bad weather, from 100 to 200 joints will be welded daily.

After the pipe is strung along the right of way the lining up gang places the pipe on blocks, align it and clamp the joints together. The tacking gang follows and tacks the pipe in three places by making spot welds. The clamps are then removed and moved ahead for the lining up gang. Following the tacking gang are the welding crews. Each crew works in units of from 4 to 10 welders depending on the length of the section to be welded. Each section is roll-welded and a section may range anywhere from 5 to 20 joints. The welding crew cuts out the tack welds as they are reached in welding around the pipe. Starting together, the crew would weld a quarter of the circumference of the pipe. All welders usually finished their quarter weld at the same time and the rolling gang turned the pipe a quarter turn for the next weld. In this manner the pipe was welded, and after a section had been welded it was rolled into place, blocked up to hold the slack and tied into the completed portion of the line.

Tying in of the Line

Tying in of the line was the most difficult of all welding and was done by the bell hole welding screw. A hole was dug where the pipe was joined and in that hole the welder had to lie flat on his back to start the weld. The pipe could not be rolled and he had to start at the bottom, placing the molten metal into the joint and welding around the pipe. Especially was this a nasty job when a welder was forced to work in mud and water.

The welding equipment consists of Oxweld generators with six generators constituting full camp equipment. Generators are mounted in batteries of two 100-pound generators to the wagon and three wagons to the division. Several 50-pound generators, eight of which make up a unit, were used also. In some instances only one generator was mounted on a wagon and sometimes skids. Such units were used where it was impossible to use the regular 1½-inch gas line or in extremely swampy country.

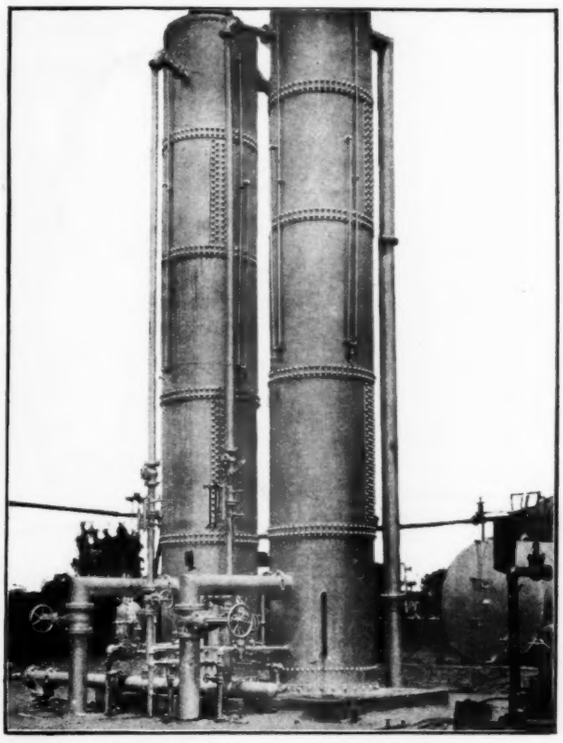
The small gas line was used to supply gas from the generators to the welders. It was 1½ inches in diameter and anywhere from 3,000 to 5,000 feet long and had outlets spaced 20 feet apart over the entire length of the line. Such a line was welded in sections of 200 feet to the section. As the work progresses a section was cut out and carried ahead to insure a constant supply of gas for the welders. As each unit of two generators was passed by the welders the generators were cut off and moved ahead for a similar purpose. Most of the torches are Oxweld torches and equipped with 50 feet of hose to the torch. In the swamp country or in country of quicksand and rotten soil, it was necessary to drag the generators through on skids.

Climatic Conditions

Various climatic conditions prevailed during the five months required in the welding of the first line. Some days the terrific heat in the low country forced the welders to work under what protection huge umbrellas offered against the scorching sun. So intense was the heat that many of the welders wore only shoes, trousers and an undershirt. Work progressed comparatively slowly and many of the pipe line crews were overcome from heat.

The nature of the country took the crews from one extreme to another, and a great portion of the country was in swamps. After the right of way had been

SOUTHWESTERN ABSORPTION TOWERS



SOUTHWESTERN Absorption Towers are designed for sustained intimate contact of the oil and gas which circulate in counter currents through the tower.

. . . The bubble trays have a patented equalizing feature which prevents short-circuiting. The gas orifices are constantly sealed by a body of absorption oil.

Complete Information On Request.

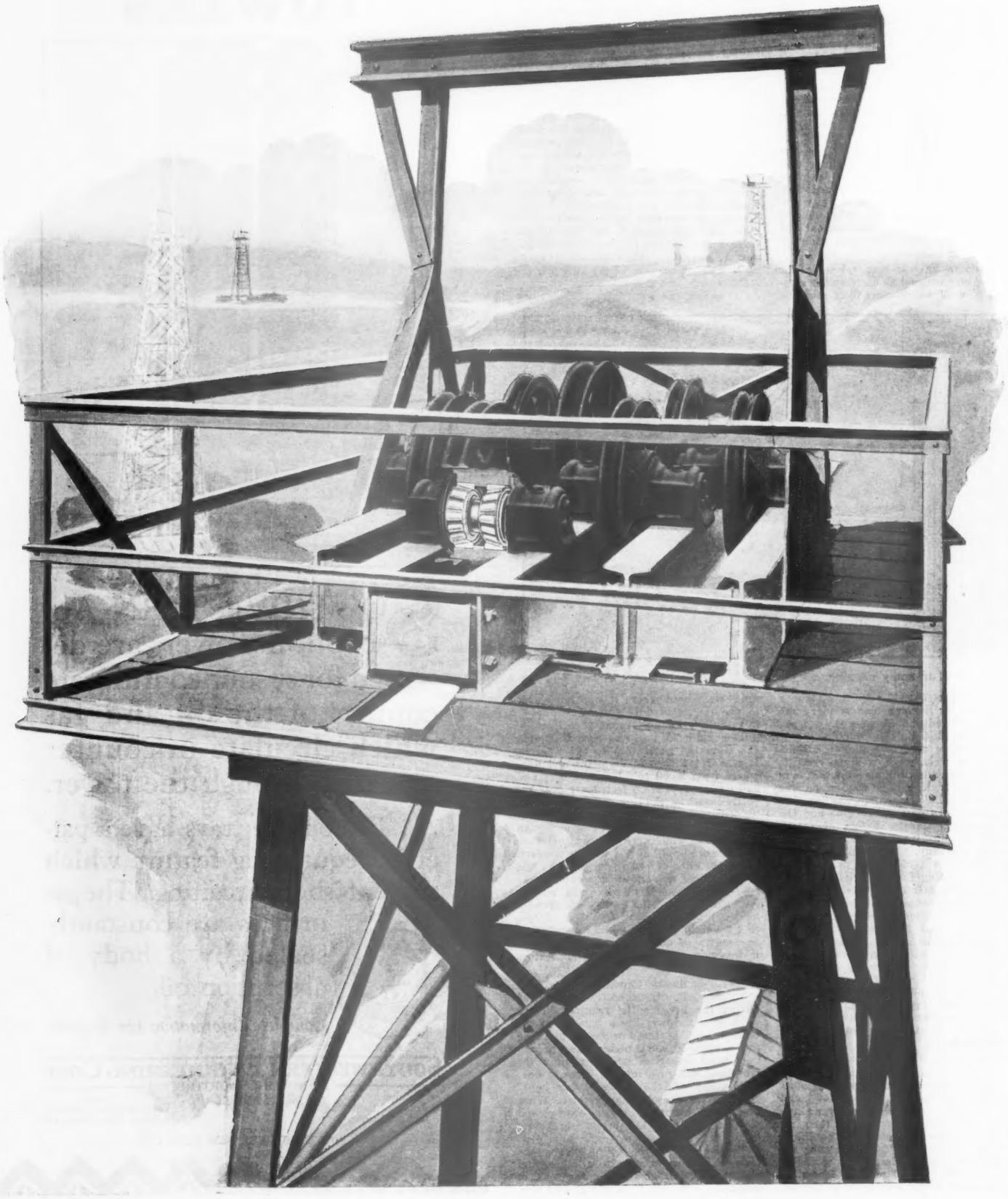
SOUTHWESTERN ENGINEERING CORP.
1221 HOLLINGSWORTH BLDG.
Los Angeles, Calif.

Branch
Joplin National Bank Bldg.
Joplin, Missouri

Branches
Western Bldg., Amarillo, Tex.
Mayo Bldg., Tulsa, Okla.

and
90 WEST STREET, NEW YORK CITY

IDECO



Roller Bearing Crown Blocks

Increase Speed Conserve Power Eliminate Trouble

Make a mental note of these "IDECO" advantages before purchasing your next Crown Blocks.

1. All sheaves made of "IDECALLOY"—a tough, wear-resisting alloy of manganese steel which takes and keeps a high polish.
2. Timken Heavy Duty Tapered Roller Bearings throughout for excess loads and severe side thrusts.
3. Alemite lubrication.
4. Ideco Crown Block supports are 12 inch Structural I Beams capable of withstanding the heaviest loads—galvanized by the Ideco Hot Dip process.
5. Patented water table clamps that permit a wide range of adjustment and will not work loose under the severest conditions. Provide quick assembly and take-down.
6. Ideco Crown Blocks carried in 5-6-7 and 8 sheave combinations.

"IDECO" Design "C" Roller Bearing Crown Blocks are designed for the most severe oilfield service, and operate under the heaviest loads at high speeds.

TIMKEN BEARINGS absorb the terrific thrust and radial loads, because of their tapered construction and positively aligned rolls.

Sheaves are made of "IDECALLOY" Manganese Steel, which gives them long life, abundant strength and practically eliminates wear on the grooves.

These frictionless roller bearing crown blocks save power, wear on the lines, and time lost through bearing troubles. Designed and tested for high speed, heavy work, they pay for themselves on the first job.

Send for our Crown Block Catalogue!

INTERNATIONAL CROWN IDECO BLOCKS

International Derrick & Equipment Co.

Columbus, Ohio **Torrance, Cal.**

California Representation: NATIONAL SUPPLY COMPANY OF CALIFORNIA—*14 Branches*

Export Representation 74 Trinity Place, New York

COLUMBUS, OHIO LOS ANGELES, CAL.

The largest company devoted exclusively to the manufacture of steel (galvanized) equipment for the oil, gas and artesian industries.

Dallas	Denver	Shreveport	Houston	Casper	Bakersfield	Oil City	Wewoka
Smackover	El Dorado, Kansas	Wichita Falls	Corsicana	Los Angeles	Mexia	Tonkawa	New York
Seminole	Drumright	Okemah	Amarillo	Panhandle	Tulsa	Borger	Pampa

cut the pipe was hauled and snaked into the high ground of the swamps. In a few cases bull teams had to be used to get the pipe through. In this low country the mud and water was anywhere from 1 to 3 feet deep. Many of the sections were welded on high ground and floated across swamps. Caterpillar tractors were employed to pull the welding equipment. They rocked and splattered their way through the low country, dragging the equipment which was mounted on skids.

Ditching of the line was not completed until January, 1925. Where practicable the ditching was done with machinery. However, the character of the country in sections made it impossible to use machinery and the ditching was done by hand. Backfilling was done with tractors and a scraper arrangement.

Welded wheel bend used at compressor stations for tying in the two suction headers.

After the line was placed in the ditch and covered it was given a hard and final test. Valves were placed along the ditched line at intervals of 5 miles apart. All valves were closed and the pressure of the line built up to 650 pounds. The pressure was held there for one hour. After that the line was blown at each valve to clean it of dirt and any other foreign matter that might be in the line.

Decomposed Soil and Quicksand

The 210-mile line from Bethany to Fort Worth goes through country with comparatively few swamps. But what grief the country saves the pipeliner by the absence of swamps it supplies with sections of decomposed soil and quicksand. In many of these sections pipe could not be strung and welded equipment moved over it. In other sections the terrain was broken with small creeks with steep banks and numerous hills.

In sections where the decomposed soil and quicksand predominated, the pipe was welded on solid ground and dragged through that particular section by tractor power. Superintendents in charge of the construction, point out that had the line not been welded it would have been impossible to lay it, except where the soil could be ditched, to insure against its being pulled apart at each joint where there was a tendency to float the line. Where the bottom lands were flooded, sections ranging from 500 to 1,000 feet in length were welded on high ground and dragged through the bottoms.

At the time this article is being written miles of the line in bottoms and lowlands are inundated. In some of the river bottoms the rapid currents carried the pipe bodily from 40 to 50 feet away from the position in which it had been laid. However, such a strain on the line did not cause it to break and no trouble was experienced in dragging the line back into position for trenching. This instance is another of the severe strains placed on the line and its strength to hold.

Because of the hilliness of the country, numerous creeks with steep banks and bends in the line, an unusual number of fire bends were necessary. Some of the creeks' banks were so steep that the trench had to be dug down in the fashion of river crossing trenches. In several places sharp bends in the line occurred in flat country and welders cut a "pie slice" from the pipe, drew the ends together and welded the pipe.

Distribution of Slack

One of the principal difficulties in securing a successful and satisfactory welded line is in the proper distribution of slack throughout the whole line to insure its being compressed at all times, thereby permitting the elasticity of the pipe itself to take care of expansion and contraction without undue strain on the welds. This was accomplished on the Bethany-Fort Worth line by blocking the pipe up from 12 to 36 inches off the ground every 250 feet. When in readiness to lower the line into the ditch precaution was taken to see that the slack went into the trench as the line was lowered. As the line is laid in compression such a method is difficult because of the stiffness of the large diameter pipe.

A large diameter line blocked up in such a manner and going through level country invariably is a curiosity. For miles and miles and until it fades in the distance the black pipe with regularly spaced "humps" appears to be a fantastic prehistoric monster looping its way across the plains.

Particular precaution is taken to insure all of the slack being lowered as the line is lowered into the perfectly straight trench. The entire line is lowered into the ditch under 100 pounds air pressure to insure against any defects developing during the lowering and going undiscovered until the final test. During the final test the line is tested under 650 pounds pressure. Had the line not been welded it would have been impossible to put in under compression while being lowered.

Usually the pipe is lowered during the cool of the morning. Lowering does not start until the work has progressed to a point far enough in advance so that the resistance will not permit the "slack loops" to creep forward and escape. As sections are lowered they are tied into the completed portion of the line and covered.

Neches River Crossing

Crossing the Neches River was the most difficult of the river crossings made by either of the two trunk lines. The river is near Beaumont. It has a 40-foot channel, a slow current and not very wide. It was crossed with eight 6-inch lines and two 8-inch lines manifolded into the trunk line some distance back from the river bank. For miles back and below the manifold to the river, ample slack is lowered into the trench to take care of an abnormal taking up of slack through the shifting of the river crossing during the high water stages.

All the crossings are welded crossings and for lines crossing most of the rivers and rapid streams the crossings were made with extra heavy pipe and without river clamps as are usually used. Where 18-inch pipe was carried across a stream or river, 2,000-pound river clamps were used at intervals close enough to hold the line in place on bottom. Where clamps were used the weld was reinforced by welding a strip of steel across the weld connecting the joints of pipe.

On the Neches River crossing where the trunk line was broken up and divided into several lines, those lines were clamped together and carried across as one section and lowered into the 5-foot trench dug in the river bed. When the line was on bottom the clamps were removed. This was done because of the river traffic and the danger of a dragging anchor hooking into the crossing. If such an accident happened then only one line would be ripped out of its place. Warning signs are scattered along the river banks warning pilots of the line.

Cutting the 5-foot deep trench in the river bed was a very difficult and expensive piece of work. Because of the depth of the channel a deep dredge had to be used. The trench had to be 100 feet wide to get the desired depth because it was constantly being filled with silt. Sixty days were required to make the river crossing and its cost went above $50,000.

The most skillful welders were used in the making up of the river crossing and after the crossing was made each weld had to stand a rigorous test. A diver was employed to aid in selecting the best crossing site and in seeing that the trench was dug properly. As in ditching the line, the river crossing was carried across and lowered in compression.

Barges and Tug Used

Freight barges and a tub boat were used in throwing the line across the river. To relieve as much strain as possible the barges supported the line until it had been taken far enough beyond on the opposite bank to permit it to be lowered into the trench. While the line was being lowered the diver observed the progress and when the line was on bottom the diver made another close examination of each weld.

Railroad crossings in many instances proved difficult on the Fort Worth line. Any pipe line going under a roadbed has to be cased in a larger diameter pipe. Many of the road beds are built high with gravel but have a soft base which caves easily. On those jobs crews had to work constantly to tunnel under the road bed and drive a 22-inch pipe as they tunneled out to make any headway. After digging a few inches the casing was driven as far as possible to prevent a cave and duplication of work. Trains roaring over the rails overhead would jar the soft dirt and cause it to cave if the train passed when only a few inches of the tunnel was unprotected by the casing. It was common for a crew to spend several days on such a crossing. The line was dragged through with a tractor.

Bell hole welder tying in section of line. Note slack in line.

Protecting the line against the corrosive elements of the soil is cared for by painting and wrapping the pipe with asbestos felt. A special priming coat with a bituminous base is painted on first. This coat is followed by a coat of specially prepared cement to permit cementing to the pipe a specially prepared asbestos felt. Two men apply the cement and two others apply the felt immediately after.

The felt is bound with small wire or hemp to hold it snug to the pipe while the cement dries. After the cement has dried another coat of cement is spread thickly over the entire covering. The felt laps around itself, both around the pipe and at every joint, and hermetically seals the surface of the pipe from corrosive elements of the soil. The pipe was ordered bare from the mills and the rust scrubbed off with steel brushes to insure a better priming coat being put on.

Pipe Line Camps

To insure a better morale among the ranks of the crews, considerable interest was taken in the camps and special thought was devoted to the swamp camps. Each camp consisted of 150 to 200 men, making up the right of way, lining up, tacking, tying-in gangs, cooks and flunkies. The camps are so arranged that each gang is segregated in tents of their own. Each camp has one large administration tent. The dining tables and kitchen are housed in one large tent. The largest gang is more fortunate than the others because that gang boasts of the best cook, who happens to be the former head chef for the leading Dallas hotel. However, in his youth he was a pipeliner and has returned to his first love.

Compressor stations for the line are looked upon as models in gas line compressor stations. The stations at Latex and Mugasco each consist of six 1,000-horsepower Cooper engines with specially designed high-pressure compressor cylinders. The auxiliary plants have two Cooper engines driving Allis-Chalmers generators. Braun company intercoolers and cooling towers are used. The gasoline plant at Latex is a Braun plant and the first one designed for high pressure. It was tested at 900 pounds hydrostatic pressure. All of the piping at the stations is welded and no expansion joints are used. The piping to the compressors was tested with 900 pounds hydrostatic pressure.

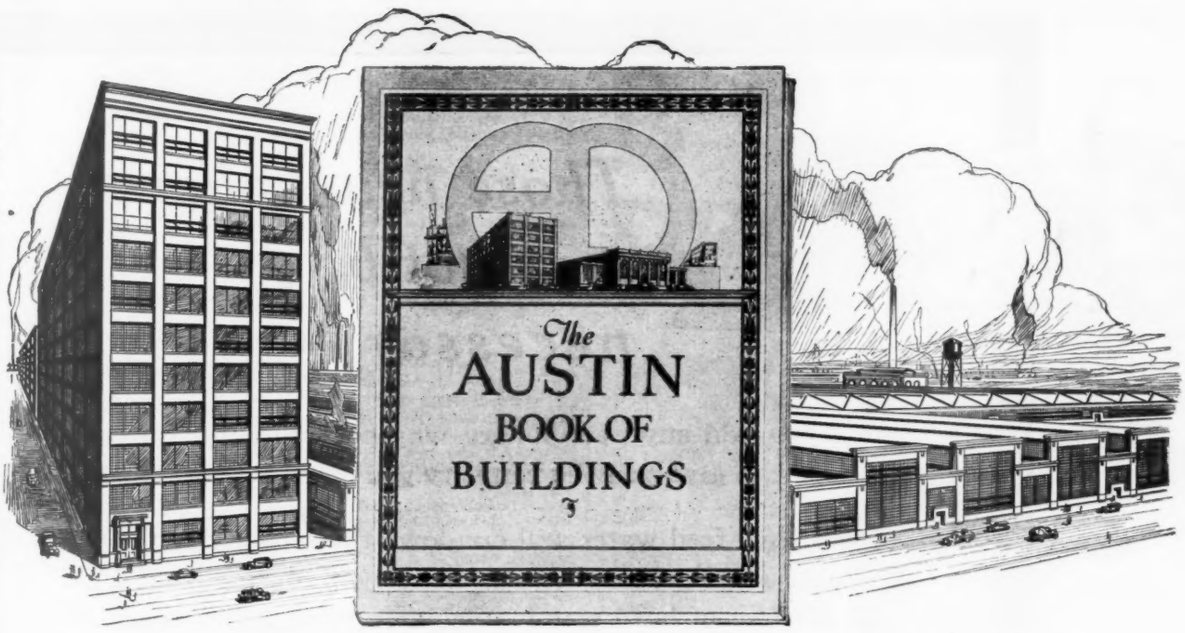
The Mineola station is laid out for six 1,000-horsepower compressors, three of which are now being installed. The auxiliary plant for this station consists of two 4-cylinder Bruce-MacBeth engines directly connected to Allis-Chalmers generators. At Sarepta, 55 miles north of Latex, a six-unit station is being and is to be completed July 1.

One example of measuring gas on the line is at the Dallas tap on the main line, which double measures the gas. The gas coming from the main line into the header is measured. Gas going into the Dallas line is measured and the gas to Fort Worth is measured.

General operations of the lines are carried on from the Latex station. At that station the general superintendent in charge of lines, general superintendent in charge of contracts and gas measurements and the chief dispatcher, general superintendent in charge of power plants are stationed.

The dispatcher's office can be compared to the chief dispatcher's office of a modern railroad. An intricate system of charts and gauges reveal to him the volume and velocity of gas going through his

(Continued on Page 342)



Executives Interested in Their Companies' Building Program Should Have This Book

Showing Latest Trends in Construction with Charts, Costs, Technical Data, etc.

WOULD you like a brief and authoritative statement that would help you determine:

—Whether the new plant buildings you propose shall be Multistory or Single Story?
—How branch plants or warehouses can be successfully located and built?
—How soil-bearing pressure may affect your building costs?
—What the advantages of a wood block floor are as against a concrete floor?
—What kind of a roof structure you should use on a given type of building?

Valuable light on these questions and many others, together with *relative costs of different types of construction*, are contained in the 100-page "Austin Book of Buildings."

This carefully prepared Austin Book of Buildings has helped hundreds of business executives to right decisions on many of the important questions in connection with their new building projects. The facts it presents on Building Design, Construction and Equipment, are supported by Austin's successful and continually growing experience of more than a half-century.

Send the Memo below, or phone the nearest Austin Office for your own copy of this helpful book.

THE AUSTIN COMPANY, *Engineers and Builders,* Cleveland
New York Cincinnati Pittsburgh St. Louis Chicago Philadelphia Seattle Portland Detroit Miami
The Austin Company of California: Los Angeles and San Francisco The Austin Company of Texas: Dallas

AUSTIN

Complete Building Service

Memo to THE AUSTIN COMPANY, *Cleveland*— We are interested in a ----------project containing----------sq. ft. Send me a personal copy of "The Austin Book of Buildings." Individual----------
Firm----------City----------
OGJ 6-16-27

This is scale—the enemy of boiler efficiency - - - a Graver Water Softener eliminates this.

Those new boilers may not be necessary!

Before you add any new boilers, why not find out if the ones you have can give you the capacity you need.

Using a hard feed water will cut down the capacity of a boiler an almost unbelievable amount. When you consider that scale —the product of hard water—insulates your boiler tubes as efficiently as asbestos it stands to reason that a scale coated boiler is a mighty inefficient piece of equipment.

Why not get all possible out of your boilers and at the same time get rid of all the petty annoyances caused by hard water? A Graver water softener will take the hard water you are now using and deliver it to your boilers soft and clean.

There are several types of water softening equipment. Each has certain qualities for certain definite uses. As Graver builds all these types a recommendation from Graver means that unbiased judgment specified the equipment for your particular needs. This is especially essential where the softened water has more than one use—for example boiler feed water and condenser cooling water.

We will be glad to study your water conditions with you.

Graver Builds

Tanks
Welded
Riveted
R.O.W. [*Riveted, Inside & Outside Welded*]
Structural Supports
Standpipes
Any Size Tanks Erected Anywhere
Pressure Tanks
Refinery Equipment
Jenkins Cracking Process
Stacks-Breechings
Steel Pipe
General Steel Plate Construction
Water Softeners
Hot Process
Cold Process
Zeolite
Household
Filters—*Pressure*
Purifying Systems *for* **Swimming Pools**

GRAVER *Corporation* *Founded 1857*
EAST CHICAGO, INDIANA

NEW YORK Grand Cent. Term. | CHICAGO America Fore Bldg. | TULSA Atlas Life Bldg. | HOUSTON West Building

KENTUCKY-TENNESSEE

(Continued from Page 68)

Coomes farm and 800 feet west of a producing well on the John Roby farm, is reported at 15 bbls. initial in the Jett sand. Same company's No. 1 on the W. H. Vaught farm, in the same vicinity, is reported a duster.

The wildcat well of the Spice Dome Oil Co. on the C. A. Bell farm, in the northeastern part of Daviess County and about 8 miles east of Owensboro, that was to be a deep test struck a heavy dose of salt water at 1,200 feet, and has been given up as a failure. This well is far from known production.

Barren County

The Lecta Pool, southeast of Glasgow, is now the most active and productive area of the Glasgow Field of Barren County and, while a dry hole is found now and then, even between producers, with the shallowness of the wells, along with the small cost of operations, the operators feel they can take a chance and drill at almost any old spot.

In the Lecta Pool, Hunt, Leach & Mitchell's No. 12 on the Vance Taylor farm is good for 30 bbls. initial from the Blue sand. No. 13, same farm, produced 30 bbls. from the same formation at 558 feet deep. J. D. White's No. 5 on the Earl Nichols farm is a 20-bbl. pumper, as is the Sanson Oil Co. and others' No. 6 on the J. H. Browning, which is good for 20 bbls. from the Blue sand at 423 feet.

In the Hall-Baker Pool the Star Oil Co. has a 10-bbl. producer in No. 19 on the Richardson farm, along the Knob Road, out of Glasgow.

In the Coral Hill district, the Stohr Oil Corp.'s test on the Duff farm is reported dry at 680 feet.

In the Emery-Moore Pool, Craig, Smith & Craig's No. 19 on the W. S. Smith farm is good for 8 bbls. at 462 feet, after given a 30-quart shot.

Other Wells

Fred C. Moore of Bowling Green, Ohio, a well-known Barren County, Kentucky, operator, is starting a wildcat on the Turner farm, near Cave City, in Barren County.

In the Scottsville Field in Allen County, Harley & Coatsworth's No. 9 on the W. H. Reed farm, pumped 1 bbl. at 205 feet, after given a 20-quart shot. Sayer & Johnson are drilling No. 4 on the Mill Hendricks farm, and Harley & Coatsworth are drilling No. 10 W. H. Reed farm.

Four miles west of Bowling Green in Warren County, Johnson & Julian's No. 12 on the J. L. Jenkins farm pumped 10 bbls. initial at 509 feet. P. H. Lavelle is drilling No. 10 W. R. Hunton farm; J. H. Wright is doing the same at No. 12 on the Ben Ford farm, and J. L. Jenkins is drilling No. 1 on his own farm.

Tennessee

The Tennessee-Kentucky Oil & Gas Co. has reached a depth of close to 400 feet at a test on the Dr. C. E. Price farm at Belmont, southwest of Manchester in Coffee County. A strata of black shale, recently penetrated, was 32 feet thick, which is considerably deeper than any shale found in wells in that section. Coffee County lies almost in the southern central part of Tennessee, southwest of Warren County and north of Franklin County, and has excellent prospects for either oil or gas, as gas has been found in quantities in both Warren and Franklin Counties, and oil showings have been found in Grundy County to the east. Coffee County is the second county north of the Alabama-Tennessee State line. The outcome of this well will be watched with interest, as it is located southwest of Clay County and almost due south across the State from Mason County, and thousands upon thousands of acres have recently been taken under lease clear across Tennessee to the southwest of Clay County.

Preparations are being made to drill a large number of tests, some already under way in the eastern part of Macon County and the western portion of Clay County, near Hermitage Springs and Red Boiling Springs. A number of oil men are now in that area and are leasing all the available territory possible. A number of fine producing wells have been developed near Celina, in Clay County, and the trend of the development is westward in the county. A deep test is now being drilled on Long Fork Creek, 2 miles from Red Boiling Springs. Hermitage Springs is in the western portion of Clay County, west and a little north of Celina and 11 miles south of Tompkinsville, Monroe County, Kentucky.

Mississippi

Additional development work is springing up in the Amory district of Monroe and adjoining counties in Mississippi. F. N. Henderson of Amory, Miss., in his report from that part of Mississippi, says: "The announcement that The Texas Company and the Arkansas Fuel Oil Co. would drill a test jointly in Monroe County, in Section 18-16-18, together with the word from Shreveport, La., that Jim Evans had ordered a derrick for a test in Lee County, in the center of Section 16-9-7, both to start immediately, and the spudding in this week of two new tests, creating a feeling at Amory that the summer will see a growing interest in oil development in Mississippi.

"A contract closed last week by the Dixie Oil Co. for a block of 2,000 acres in the southern part of the State was good news to the independent operators in the Amory Field. L. B. Mawk spudded in on his No. 1 Seavey lease in Section 22-13-7, and the Lee County Petroleum Co. will start drilling at once on the Hickman farm, in Section 12-8-6, Lee County. The Cumberland Oil Co. in Webster County on the Hanley land in Section 15-21-11, is setting 8-inch for a test at 1,184 feet. The Hall test of the Amory Petroleum Co. in Section 8-13-17 is reported shut down at 2,404 feet, where they set 8-inch. The Dill farm test of the same company in Section 12-13-18 is drilling at 1,740 feet.

"The Rye test of the Natural Gas & Fuel Corp. in Section 22-15-17, is down 595 feet in rock at a depth of 1,200 feet. The Buffalo Oil & Gas Co.'s test on the Crook farm, in Section 4-13-18, is drilling in rock at 822 feet. The Sutton test on the Acker farm in Section 25-13-17 is shut down waiting for bit at 373 feet, where a string of 10-inch was set. The Bassfield Oil Co. on the Burkett farm in Jefferson Davis County in Section 14-6-18 is drilling at 1,100 feet. The A. Nye Jones test on the Kendall land in Section 15-2-4, Simpson County, is drilling at 1,300 feet. Machinery has arrived from Redfield, Ark., for the Zuendt test on the Taylor farm in Section 30-14-17, Monroe County."

EASTERN FIELDS

(Continued from Page 65)

County, the Heck Oil Co. has a 5-bbl. pumper in the Berea grit at No. 5 on the D. H. Borrougs farm.

In Sheridan district, Calhoun County, W. H. Bickel's test on the J. H. Barnes farm is a gasser. In Liberty district, Marshall County, the Manufacturers Light & Heat Co.'s No. 3 on the Samuel C. Howard farm is a gasser in the Gordon sand. In the same district, the Hope Construction & Refining Co.'s No. 6 on the I. G. Logsdon farm is showing oil in the Gordon sand.

On Nutter Fork, Grant District, Ritchie County, the Hope Construction & Refining Co. shot its old No. 5 on the I. M. Smith farm and increased its production from 5 to 25 bbls. a day.

Starting and Drilling Tests

On the Kanawha River, Sheridan district, Calhoun County, the Hope Construction & Refining Co. has the rig completed for a test on the A. Hardman farm. In Sherman district, McIntosh & Miller have the rig completed on the A. Shook farm. In Lee district, Godfrey L. Cabot has completed a rig on the Ferris Barr farm. In the same district, the Ohio Fuel Oil Co. is fishing for a string of tools on the J. L. Stump farm. In Sheridan district, the Chemical Oil Co. has a rig up on the Bennett-Saunders farm. In Sherman district, McIntosh & Miller have made a location on the S. B. Minney farm.

In Union district, Harrison County,

(Continued on Page 337)

This is No. 38 of a series on specifications—keep for reference in ordering.

BARSCO PRODUCTS

---for Oil and Gas Well Drilling

BARSCO Die Nipples, male and female or combination, are constructed from special *forged steel* having a tensile strength of from 90,000 to 110,000 pounds.
The flutes are fabricated so as to shut off water.
The name BARSCO stamped on each nipple is your guarantee of lasting service—place your order for BARSCO.

SPECIFICATIONS

Size Pipe, Inches	Length, Inches	Weight, Pounds
2	10	15
2½	10	15
3	10	15
4	10	20
4½	10	20
4¾	10	20
4⅞	10	20
5⅛	10	20
6	11	30
6¼	11	30
6⅝	11	30
8¼	12	40
10	12	60
12½	14	105
14	15	115
15½	15	150
16	15	150
18	16	170
20	16	195

Intermediate sizes, also sizes larger or smaller than listed can be furnished.

Note:—Smallest inside measurement is the same as inside diameter of pipe or casing on which nipples are to be used. In ordering, give size, weight, pitch of thread and make of casing on which nipple is to be used and also size and weight of casing through which nipple is to pass.

Stocks carried by Dealers.

BARTLESVILLE SUPPLY COMPANY of Missouri
3400 MAURY AVENUE—ST. LOUIS, MISSOURI
Export Office: 150 Broadway, New York City

Manufacturer's Representatives

B. & A. Specialty Co., Tulsa, Okla.
Miller Tank & Supply Co., Casper, Wyo.

—Write for Complete Catalog

B & A GASCO

This is No. 4 of a series on B & A products

Look for No. 5 June 30th Oil and Gas Journal

B & A UNDERSLUNG ROD ELEVATOR

MACHINED—

all parts interchangeable

The B & A Underslung Rod Elevator is machined allowing close fitting with accuracy—consequently you get a long wearing smooth operating elevator.

All wearing parts renewable and interchangeable makes this the most economical piece of equipment you can buy. The small operators just like the big ones like B & A features because they both save money.

The B & A Quality Line

Baker Casing Shoe Co.
Bartlesville Supply Co.
Acme Fishing Tool Co.
Garrott Brass & Machine Co.
Dexter Valve Reseating Machines
Novo Engine Co.
Robinson Orifice Fitting

Have you our prices and specifications? Write now.

B & A SPECIALTY COMPANY
220 East Brady St. Tel. 3-3282
TULSA, OKLAHOMA
312 Keystone Bldg., Houston, Texas

B&A Specialty Co

GAS IN LOUISIANA AND IN NORTHERN ARKANSAS

(Continued from Page 70)

prolific source of gas of any formation of Cretaceous age. It ranges in depth from 300 feet in the Bellevue Field to 2,100 feet, or deeper, in the Monroe Field.

It is the source of gas in parts of the old Caddo Field, Hosston, Shreveport gas field, Waskom, Bethany, Sligo, Elm Grove, Bull Bayou, Bellevue, Homer, Sarepta, Cotton Valley, Monroe, Richland, El Dorado, East El Dorado, Urbana and Smackover.

In Elm Grove, Sligo, Bethany, Waskom, parts of the Sarepta area, Monroe and Richland, gas only is found in the Nacatoch. The crests of Cotton Valley, Smackover and Hosston structures produce gas, with oil in the same sand further down the structure.

Blossom Sand

At no place in the district, except in a few wells in the Smackover field, does the Blossom sand produce gas exclusive of oil; gas is always accompanied with oil. The Blossom sand is primarily an oil sand with an occasional gas well in the oil fields.

Woodbine Sand

Gas and oil are both products of the Woodbine sand. In Shreveport and Elm Grove fields gas only is produced from this horizon. In Caddo, Bull Bayou and Sligo fields gas and oil are associated together. In none of the other fields has the Woodbine been found commercially productive.

Glen Rose

In the Pine Island Field, the 2,900-foot horizon of the upper part of the Glen Rose produced oil and some gas. At a depth of 3,600 to 3,800 feet, some of the largest gas wells of the State are being developed in what appears to be at a point near the base of the Glen Rose formation. At approximately the same horizon, oil is also developed. One of the big gas wells of this field, the Gulf's No. 12 Tyson, after producing gas at the rate of 35,000,000 cubic feet for a period of nearly a year, recently began making oil and is now producing better than 500 bbls. a day.

In the Cotton Valley Field, the upper Glen Rose horizon is the source of a gas very rich in gasoline content. The depth of the producing horizon is about 4,400 feet.

The size of the Cotton Valley wells varies from 3,000,000 to 12,000,000 cubic feet a day and carry as high as 1,200 gallons of gasoline to the million cubic feet.

The Richland gas field, which is separated from the Monroe gas field by a low saddle, has found gas in the Lower Cretaceous, but the exact horizon has not yet been determined. It occurs only a few feet below the contact between the Upper and the Comanchean Cretaceous.

Geologic Structure

Only a few years ago, geologists were largely in unison in condemning any faulted area as a possible source of oil and gas. This idea, however, was soon changed and at the present time faults are found to have a direct bearing, in many instances, on the accumulation of oil and gas, especially those that occur at right angles to the regional dip of the formations. Where there has been a doming against the fault, the uplift side forms an ideal trap for the accumulation of oil and gas. Examples of this kind are to be found along the faults east of the Balcones zone of faulting in eastern Texas.

Another type of folding is found in the Homer Field of Louisiana, which is an asymmetrical dome that has been closely folded and broken along the crest of the dome. All of the oil and gas in this field migrated upward along the fault plane and was trapped in two different sands approximately 700 feet apart, the oil in each sand being identical.

In the Smackover Field, a large fault extends in an east-west direction along the north side of the field with a well developed dome, the highest part of which is 3 miles south of the fault. That the fault has had some influence upon the accumulation of oil and gas in this field there can be no doubt.

The large fault east of the Stephens, Arkansas, Field has doubtless been responsible for the accumulation of oil in that field. It has at least affected the folding. The same can be said of the Nevada County, Arkansas, Field.

A large fault extends through a part of the Bull Bayou-Crichton Field and is responsible for the accumulation of oil in that field.

As far as the evidence goes, there is no faulting in any of the purely gas fields of this general area. All of the faulted structures have produced oil and gas, while many of the unfaulted structures have produced gas only.

Relation of Sand Lenses

Theoretically, a lense of sand, which occurs in an impervious bed of oil-bearing shale, is as efficient a trap for the accumulation of oil and gas as a well defined dome. Oil and gas fields, which have been developed on sand lenses, have been difficult to work out in advance of drilling. Many of these sand lenses have been formed by ancient streams whose courses have been determined in a general way by drilling, with the result that certain trend-fields have been predicted in advance of drilling. The old El Dorado, Arkansas, Field is an example of the sand lense, which is responsible for accumulation of oil and gas.

The same can be said of the area south of the old Bull Bayou Field in Louisiana, especially of the new Sabine Field which is now being developed. Practically all of the other fields in this general district are blanket or sheet sands which extend over wide areas.

Surface Structure

On account of the rapidity with which the surface formations of northern Louisiana and southern Arkansas break down under the weathering agencies, and the scarcity of resistant key beds, it has been difficult to work out surface structures in this area. Recently, however, remarkable results have been obtained by the intensive study of the marine formations of this area, especially those that carry forams. Some recent salt domes have been discovered in northern Louisiana by means of intensive study of the fossil-bearing formations.

Where entire formations are involved, it is not difficult to work out a regional uplift, like the Sabine or the Ouachita uplifts, by means of the study of surface stratigraphy, but it has been difficult to outline small, isolated structures, where only a portion of one formation is involved in the movement. The microscopic study of forams, in this general area, has shed a great deal of light and made easier the discovery of the small structure.

The former custom of relying on surface dips in the endeavor to work out structure has largely been abandoned throughout this area. It has been difficult, if not impossible, in many instances, at least, to distinguish between a true dip, caused by the folding of the formations, and cross-bedding, which is very common in surface outcrops of the area under discussion. In the study of salt dome structure, surface dips may play an important part, and must not be disregarded entirely.

Subsurface Structure

With the abandonment of surface dips in working out large anticlines has come the more intelligent study of well logs for the purpose of outlining true structural conditions. While well logs are often inaccurate, the major changes in the formations can be readily discerned and make subsurface contouring more reliable than contouring on surface stratigraphy.

Gas Fields

In not a few of the gas fields of this area gas is intimately associated with oil, particularly in the early development of the fields. Where gas and oil originate from the same sand, gas in soon exhausted and oil only is produced.

Caddo Gas Field

In parts of the Caddo Field gas was produced from the Nacatoch horizon. The Woodbine was likewise the source of a large amount of gas which was used in the early development of the field for drilling rigs and for domestic purposes.

The top of the Hosston structure produced gas from both the Nacatoch and

No other rod has the milk bottle cap or the Jones thread protector. Threads made to A. P. I. Standards if desired.

GIANT JONES SUCKER RODS

No matter what thread is used it is only as good as the machine work.

Examine
A Jones Giant Rod
Compare it Carefully—
Ask the man in the field—
And you too will buy
this really better rod.

The Largest Manufacturers of Sucker Rods in the World.

THE S. M. JONES COMPANY.
TOLEDO, OHIO.

Mid-Continent Office: 602 Wright Bldg., Tulsa, Okla.

The G-R Bentube Section

AN atmospheric cooler that automatically cracks off the scale formed on the outside of the tubes by the pronounced bowing of the tubes on change in temperature whenever steam or vapor is admitted to the section.

This scale-shedding action keeps the scale from building up to a thickness that will reduce the heat transfer rates below those for which the cooler is designed.

These sections are standard and interchangeable, provide for expansion, drainage and easy cleaning, are easily moved to new locations, and can be added to as desired for increase in capacity or greater cooling effect.

The many advantages of the G-R Bentube Section—its exclusive scale-shedding feature, interchangeability, long life, flexible capacity and high salvage value, make it well worth your further investigation.

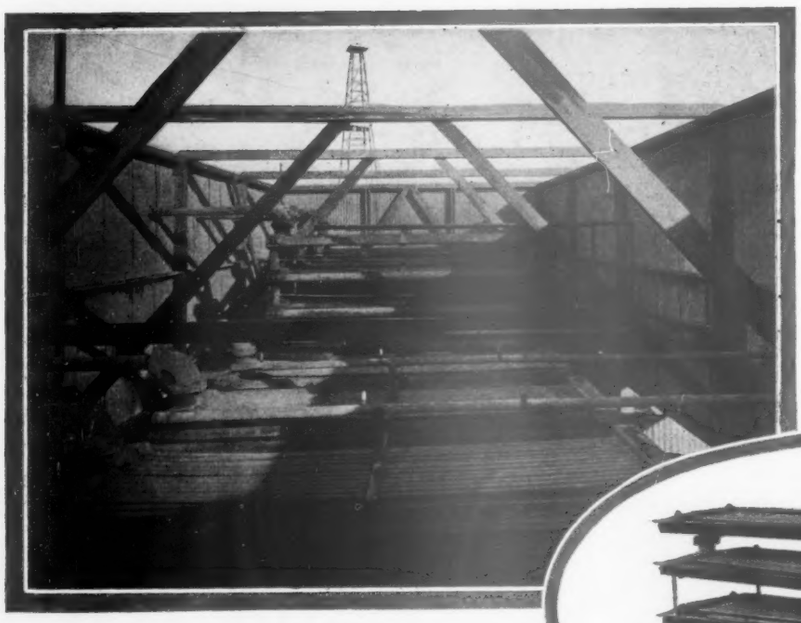
Send for bulletin

THE GRISCOM-RUSSELL COMPANY
285 Madison Avenue

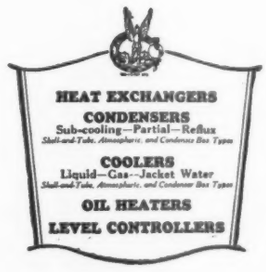
Philadelphia	Chicago	St. Louis	San Francisco
Boston	Detroit	New Orleans	Los Angeles
Rochester	Cleveland	Dallas	Seattle
Pittsburgh	Milwaukee	Houston	Salt Lake City
Columbus	Minneapolis	Atlanta	Tulsa
Indianapolis	Kansas City	Charlotte	Denver

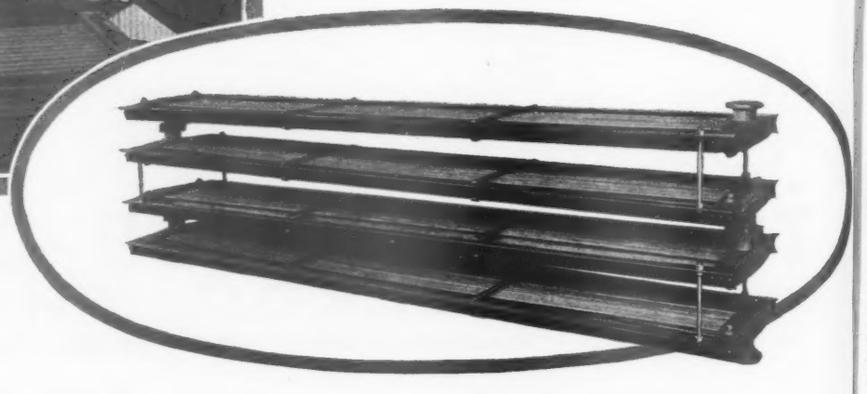
For Canada: Riley Engineering and Supply Co., Ltd., Toronto

Griscom-Russell
Heat Transfer Apparatus



Typical Installation of G-R Bentube Section





the Woodbine horizons. From 85 to 140 feet down from the top, on the north side, a heavy asphaltic oil is being produced. No oil has been found on the south and east sides. The Hosston gas field has long since been exhausted.

Shreveport Gas Field

The source of gas from the Shreveport gas field was both from the Nacatoch and from the Woodbine horizons. The field has been thoroughly drilled and the gas exhausted.

Elm Grove Gas Field

The Elm Grove gas field was the principal source of gas for Shreveport and the Little Rock gas line from 1916 until gas was piped into Shreveport in 1919, from the Bethany Field.

The Nacatoch and the Woodbine sands are both gas bearing. No oil has been found associated with gas from these horizons.

The Blossom sand, in the Elm Grove Field, carried gas, but its association with water prevented the use of the gas. After the field was largely developed the Blossom sand, on the very crest of the structure, was found to contain oil which is now being produced in relatively small quantities.

Compressor stations have been installed in the Elm Grove Field for recovering the small amount of gas which now remains in the sands. Two or three years will see the exhaustion of gas from this field.

Gas was discovered in the Elm Grove Field in 1916, and with the heavy withdrawals that have been made, and the fact that in the early development of the field one or more wild wells were not killed, but were allowed to blow themselves out, it is remarkable that the field has produced as long as it has.

Sligo Gas Field

The Sligo Field is a twin structure to the Elm Grove Field and is connected with the latter by a low structural saddle. It was not discovered until 1922 and is now producing gas from the Woodbine sand. When fully developed, the producing area will cover about 6,000 acres, or about one-third the area of the Elm Grove Field. It is connected to the Elm Grove gas line.

Monroe Gas Field

The Monroe gas field is located in the low-lying area of the Ouachita River bottom where all of the Tertiary sediments are completely covered by river alluvium.

In drilling for potable water over what later proved to be the Monroe gas field, gas was found in all of the shallow fresh water sands. The first commercial gas well was drilled in 1916.

The area covered by the Monroe gas field embraces approximately 350 square miles.

The gas comes from the Nacatoch horizon which varies in depth from about 2,100 feet on the crest of the structure to 2,300 feet on the margins.

The initial pressure in the first wells drilled was 1,025 pounds per square inch. The average pressure at the present time is 784 pounds per square inch.

Monroe is considered one of the principal sources of the future gas supply of the state. An estimate of the total amount of gas in the reservoir in 1921 was 4,750,000,000,000 cubic feet or a sufficient amount to permit the daily production of 150,000,000 cubic feet per day for a period of 40 years.* The present daily withdrawals amount to 370,705,616 cubic feet, which will curtail the life of the field to approximately 16 years.

More than 90 per cent of the gas from the Monroe Field is consumed in the production of carbon. In 1925 the carbon made from the Monroe gas was 77 per cent of the world's output. In 1924, 141,675,944 pounds of carbon black was made in the Monroe Field.

In the southeastern part of the field the gasoline contents of 400 gallons per 1,000,000 cubic feet are reported, with a greatly reduced amount in the northwestern sector of the field.

Cotton Valley Field

The Cotton Valley structure may be considered a perfect textbook type of folding. It is an elongated, egg-shaped dome with gas occupying the crest and a rim of oil completely encircling the gas, with salt water in the synclines.

*Bulletin No. 9, Louisiana Conservation Commission, page 86, July, 1921.

Gas is being drawn for commercial use through pipe lines connecting the field with Minden, Beaumont and Shreveport.

Gas is produced from the "Blossom" or Haynesville sand from 2,500 feet to 2,600 feet, and from the upper Glen Rose around 4,400 feet. The latter gas has been found to contain a very high gasoline content, exceeding 1,200 gallons to 1,000,000 cubic feet of gas. Gasoline absorption plants have been installed and the gasoline is removed before the gas is put through the line for commercial consumption.

Sarepta Gas Field

The Sarepta gas field is here designated as all that northern tier of townships bordering the Arkansas line between the Haynesville oil field on the east and Plain Dealing on the west.

Some large gas wells have been developed in this area, the first of which was known as the Munn well in Section 1-22n-10w. Gas from this well largely supplied fuel for the drilling rigs and pumps in the Haynesville oil field and later supplied the town of Haynesville.

Gas from this general area is frequently so intimately associated with oil and salt water that it is difficult to separate them. Numerous attempts have been made to make oil wells in this area, but the majority of the wells in the proven area have been gas wells.

Gas is produced from the Haynesville horizon about 190 feet below the base of the chalk.

Some recent completions in Township 23n, Range 12w, have opened a new sand from a depth around 3,090 feet, or about 380 feet below the Haynesville horizon. Wells from this lower horizon are reported to be making 35,000,000 cubic feet of gas and others are making less gas and a spray of oil. The field is still in its infancy and may develop into an important gas field, with the possibility of an oil field around the edges of the structure.

Pine Island Deep Gas

From a depth varying from 3,623 feet to 3,800 feet, or even deeper, there has been developed a new source of gas and oil in North Louisiana. This gas is coming from the lower part of the Glen Rose formation.

Some of the wells from the Glen Rose horizon are capable of producing as high as 45,000,000 cubic feet of gas a day.

The initial gas pressure on these wells runs as high as 1,550 pounds per square inch.

The gas is rich in gasoline and one of the wells, which was completed as a 35,000,000-cubic-foot gasser, later began making oil at the rate of 12 bbls. a day and gradually increased that amount until it is now producing approximately 500 bbls. a day. Another well from the same sand has been producing more than a year, and although the pressure has reduced, it has shown no signs of changing to an oil well.

Two gas lines are partially served from the Pine Island deep gas. One is the Arkansas Natural Gas Co.'s line to Little Rock with all the intervening towns. The natural pressure from these wells is sufficient to force gas through the line to Little Rock without the aid of the pumping station.

The gas lines serving this region are shown in the map accompanying this paper.

The gasoline is removed from the gas by means of forcing the gas through an absorption plant in the field, before the gas is sent on its way to consumption.

Bethany and Waskom Gas Fields

Bethany and Waskom gas fields are both on the line between Louisiana and Texas with the greater part of each field in Texas, but they are on the North Louisiana Sabine uplift and belong in the geologic group of the Louisiana fields. The two are on the same general structure, connected by a high saddle, which does not produce either gas or oil.

The Bethany is the older of the two fields and originally produced gas from the Nacatoch, and from the 2,600-foot or "Adams sand" of Washita age. This field is practically exhausted, except for some gas in the Nacatoch sand in areas yet to be drilled.

The Waskom Field is producing gas

(Continued on Page 392)

"Sully" the Chemist says—

"3 of a Kind

Sulco Products are always trumps in the oil game"

Operators the world over know that they sit in on a winning game when they use Sulco Products. Here's 3 of a kind for speeding up production:

KONSET

For cementing casing. Accelerates, Hardens and Waterproofs. Bonds to the wall and anchors in the strata. Shuts out water permanently under all conditions and nullifies the destructive action of bottom-hole chemicals. Okeyed by Petroleum Departments of 3 Governments. Saves 12 days per well, or better. For use with cement anywhere around the lease.

KLEEN-A-WELL

Removes paraffine, or asphaltum from oil wells, gypsum or salt from gas wells. Cleans tubing and rods. Increases production.

SLUSHMIX

The improved mud-heavier. Increases weight 100%. Controls the pressure, greases the bit, reinforces the walls. Removes cuttings to surface. Superfine. Smoother.

For Sale by Any Supply Store or Lumber Yard

The SULLIVAN *Company*

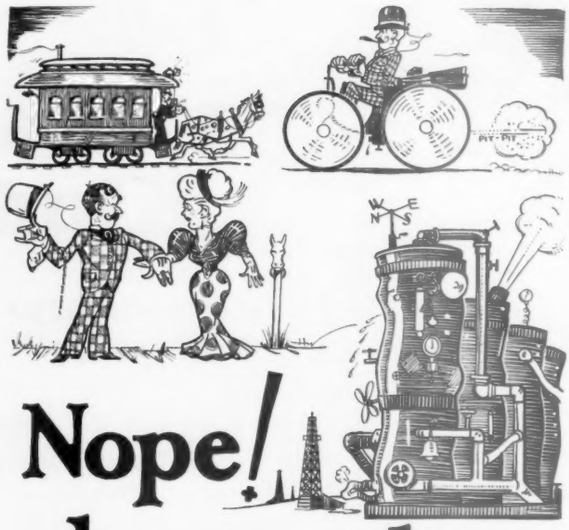
Memphis, U. S. A. Montreal, Can.

Address Inquiries to

SULCO LIFE PRESERVERS FOR THE OIL FIELDS PRODUCTS

General Offices Memphis, Tenn.

Life Preservers for the Oil Fields



Nope!

by-gone days *are* still here for some Absorption Plants !!

In the early days of gasoline production—and not so very long ago—almost any kind of baffle tower was used. Some absorption plant operators are still clinging to the obsolete while others are profiting by the installation of Campbell Oil-Froth Absorbers. If your plant is out-of-date let Campbell efficiency step in and increase your profits.

J. A. Campbell

Consulting—Designing—Construction

Natural Gas Engineer

P. O. Box 669 LONG BEACH, CALIF.

CAMPBELL

OIL FROTH

absorber

PIPE ORDER FOR DENVER GAS LINE REPORTED TO HAVE BEEN BOOKED

By B. E. V. Luty

PITTSBURGH, Pa., June 13. — The trade understands that the National Tube Co. has booked an order for 100 miles of 16-inch and 60 miles of 12¾-inch line pipe. This is supposed to be for the long talked of natural gas line from the Amarillo Field, Texas, to Denver, Colo. Originally the line was spoken of as requiring about 400 miles of 22-inch. There is a rumor that an order has been placed with the A. O. Smith Corp., Milwaukee, Wis., for 300 miles of 22-inch, but this is not confirmed, the idea being that the 300 miles of 22-inch is still under negotiation and that the orders mentioned above plus the 300 miles would make up the main part of this gas line, some smaller pipe for feeders and distributors to be placed later.

No other line pipe business of particular consequence has been reported lately, but it is still believed that the three companies making the largest sizes of line pipe have a good bit of business left on books of this description.

Demand for casing has continued very light, making no comparison at all with demand at this time a year ago, when a very active season had started. Just how much decrease there has been this year in oil country goods outside of line pipe is not estimated, but the decrease must have been large. Some of the mills figure that their total in all oil country goods has decreased but little, line pipe going far towards making up the difference. In merchant or standard pipe the decrease this year from last has been close to 10 per cent.

Operating Ratio

Estimates are made in some quarters that the pipe industry as a whole is operating at about 70 per cent. Such estimates while generally indicative are never very close. When mills are operating particularly well or particularly poorly they do not care to disclose the facts, and last year's operations may have been somewhat underestimated, with this year's operations overestimated, for two or three months ago there were claims of an operation of 80 to 85 per cent, which would show little variation from a year previous whereas the marketing conditions have not been nearly as good.

The steel industry as a whole maintains a very good operating rate, between 80 and 85 per cent, showing no more decrease from the March rate than had occurred at this time last year, it being normal, according to the experience of several years, for operations to decline after March and into July.

The tonnage of bookings keeps up better than might have been expected considering the fact that for weeks there has been little large lot buying in any quarter. There is a multiplicity of small orders, mills doing more of a retail business than ever.

Steel Lettings

For three weeks past fabricated structural steel lettings have run about one-third smaller than the pace earlier in the year, but this line is always having its ups and downs. There has been very little freight car buying since January. The automobile industry has been running, since January 1, at about 10 per cent under its rate in the same period last year. Production of automobiles is running considerably lighter this month, but a substantial increase is expected in the new two months, on account of new models coming out, particularly with Ford and Dodge.

Finished steel prices hold without any quotable change. Irregularities continue in various lines, largely according to section, there being more shading in the East than in the Central West. On the whole prices are probably a shade softer than a month ago, with the exception of sheet prices, as the advanced asking prices are holding on the limited business now being placed, buyers being fairly well covered at prices below the present advanced market. Coke, pig iron and scrap are dull and unchanged.

PIPE LINE FROM IRAQ TO THE MEDITERRANEAN

King Feisal of Iraq stated at the opening of the new refinery at the Khanaqin Oil Co. that a pipe line from Iraq to the Mediterranean would be constructed—the first authoritative public statement that such a pipe line would be laid. Its importance will depend on the productive capacity of the field; but this is expected to be large. The Khanaqin Oil Co., unlike the Turkish Petroleum Co., is a direct subsidiary of the Anglo-Persian; and its drilling on the Naft Khana property, on the borders of Persia and Iraq, has been successful beyond the average.

A pipe line from near the Persian frontier in the vicinity of Naft Khana offers, the London Oil News says, opportunity of extension through Persian territory to the Anglo-Persian Field at Maidan-i-Naftun, now renamed Masjid-i-Suleiman. Such a line would supplement the Anglo-Persian's present line to Abadan, on the Persian Gulf, which is approaching the limit of its capacity. At present the transport of Persian oil to Europe is dependent upon the Suez Canal. Modern methods of warfare could easily close that canal by bombs or otherwise; even a large vessel run aground and destroyed might hold up traffic for months. The proposal of a pipe line across the Isthmus of Suez has certain merits, and is no new idea; but the fact that speaks loudest is that the Anglo-Persian has so far taken no steps to carry out such a project. A pipe line from the Persian fields via Iraq would serve the double purpose of increasing Anglo-Persian transport capacity and avoiding war risks in connection with the Suez Canal. If—as seems possible—new oil fields are developed between Masjid-i-Suleiman and the Iraq frontier, a shorter Persian link would be possible.

RUSSIA'S POTENTIAL OIL AREAS

An article in the Bulletin of the American Association of Petroleum Geologists by Arthur Huber Redfield, Bureau of United States Department of Commerce, on "The Petroleum Resources of Russia," states that there are indications of oil and gas in European Russia in the northern and central parts of the great Russian platform, whose gently folded and faulted structure should encourage drilling. Commercial production, however, has been confined almost entirely to the downfold or downfaulted basins of the south, the Black Sea Basin and the Caspian Basin, as well as the Kura and Kutais Basins of Transcaucasia. Of the vast territory of Asiatic Russia, the most promising part for future oil supply seems to be the downfolded or downfaulted basins of Russian Central Asia, filled with folded marine Jurassis, Cretaceous, and Tertiary strata; and the highly folded Tertiary beds of the east coast of northern Sakhalin. Some possibilities of oil or gas may exist in the broad plain between the Ural Mountains and Yenisei River, but these remain to be demonstrated. Oil has already been produced commercially in the basin north of the Caspian Sea, in the Transcaspian Basin east of the Caspian Sea, in the Ferghana Basin of eastern Turkestan and recently in northern Sakhalin.

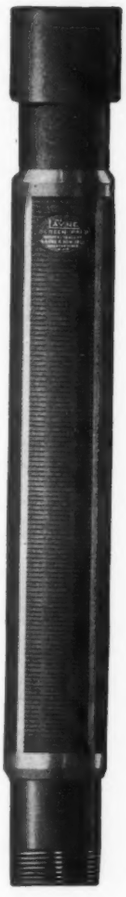
NIPPON OIL STRIKE

Interesting news is reported by the Nippon Oil Co., the chief oil-producing concern in Japan, concerning the Shukoko Field at Taiwan, where a well is being sunk to test the possibility of extending this field in a southerly direction. Oil was struck at 763 meters, the well flowing about 2,000 bbls. a day.

THE LAYNE

25 Years Experience

At Solving Oil Screening Problems



Have proven that the best way to get maximum production is by using

THE LAYNE

Patented Wire Wrapped Screen

—

Special material, accurate workmanship, and close inspection of the finished product are combined in the manufacture of the Layne Screen

—

Write, phone, or wire your needs

The Layne & Bowler Co.

HOUSTON, TEXAS.

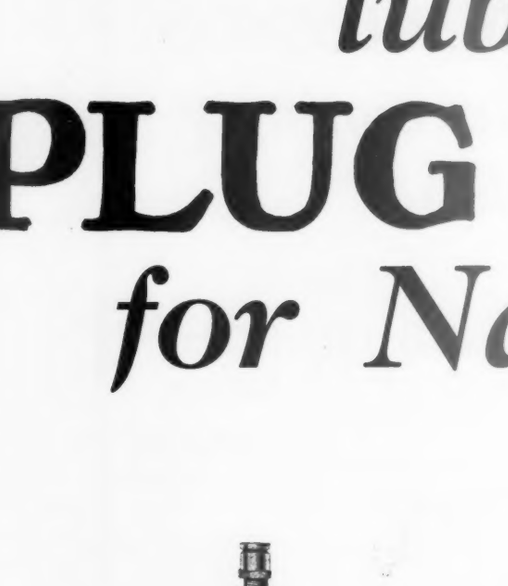
VICKERS, LIMITED — THE LAYNE & BOWLER CORP.

BARCO

lubricated

PLUG VALVES

for Natural Gas



THE only plug valve suitable for high pressure service! It is normally tightened by pressure instead of being loosened because the plug tapers toward the gland.

But it is not exclusively a special service valve. It is in wide use on every day jobs handling gas, oil, water, steam, acid or alkali, cold or hot, low or high pressure. It does all these jobs well and at low upkeep cost for it has all the advantages of any plug valve with none of the disadvantages of ordinary valves of this type. It gives a full direct port opening with only a quarter turn of the handle, there is no chance for foreign matter to obstruct its operation, its simple construction insures long life, its balance and lubrication prevent sticking, its maintenance is reduced to a twirl of the thumb on the lubricator. Try a Barco on the line that's giving you trouble.

Barco Manufacturing Company

1801 Winnemac Avenue, Chicago, Illinois

O&GJ 6-16, 16-Gray

EASTERN FIELDS

(Continued from Page 329)

Benjamin Bowman is drilling on the Emma Holden farm. In Ten Mile district, the Grasselli Chemical Co. is due in the sand on the Margaret Bannon farm. In Central district, Doddridge County, W. H. Bickel is due on the W. H. Barnes farm.

In Union district, Ritchie County, the Carnegie Natural Gas Co. is drilling a test on the A. R. Brake farm. In the same district, D. M. Heckert is due in the sand at a test on the A. L. Britton farm. In Murphy district, Joshua Haught and others have shut down for casing on the Joshua Haught farm. Pope Brothers have shut down for orders at No. 7 J. H. Gamble. In the same district, the Hope Construction & Refining Co. is drilling on the Neil Bradley farm. In Mannington district, Marion County, the Clifton Oil & Gas Co. has shut down for casing on the Belle Snyder farm. In the same district, the Hope Natural Gas Co. is due in the sand on the O. J. Cunningham farm.

Cabell County

In Grant district, Cabell County, the Monickel Gas Co. is building a rig on the Elizabeth Johnson farm. In Barboursville district, Ortman & Sipe have made a location on the G. W. Lithucom farm. In McClelland district, Doddridge County, the Little Five Oil Co. has started to drill on the G. W. and A. Farr farm. In the same district, the Manufacturers Light & Heat Co. is drilling on the Josephine Boyce farm.

In Spencer district, Roane County, G. L. Cabot is rigging up on the O. E. Goff farm. In Ravenwood district, Jackson County, E. L. Boem has shut down for orders at his wildcat on the Pearl Burch farm. In Union district, Wayne County, the Chartiers Oil Co. is due in the sand at a second test on the A. G. Damson farm.

In Smithfield district, Roane County, Godfrey L. Cabot is rigging up at a second test on the T. M. Perot farm. In Reedy district, Roane County, the Heck Oil Co. has started to drill No. 9 on the J. W. Conley farm. The Hope Natural Gas Co. has started to drill on the J. P. Knight farm, in Sheridan district, Calhoun County. In McElroy district, Tyler County, J. H. Pentz is drilling deeper his second test on the Soloman Kyle farm. A location has been made on the Albert Stoneking farm. In Magnolia district, Wetzel County, the Silver Hill Oil Co. has started on the Albert Barth farm.

In Grant district, Cabell County, the Monickel Gas Co. has started to drill on the Elizabeth Johnson farm. In the same district, the Big Two Mile Gas Co. is due in the sand on the Gilbert Moore farm. In Union district, Marshall County, the Decem Development Co. is rigging up on the Campbell heirs' farm.

Southwest Pennsylvania

In Greene Township, Beaver County, George Freshwater has drilled through the Gordon sand his No. 3 on the Hugh Laughlin farm. It is a duster. In Perry Township, Greene County, the Carnegie Natural Gas Co. has a light gasser in the Bayard sand on the Elmira Jones farm. On Morris Township, the Consumers Fuel Co.'s No. 3 on the Frank Rutan farm is holding up at 25 bbls. a day.

Near Glenshaw, Shaler Township, Allegheny County, in very old territory, J. S. Walley and others have drilled in a test on the James E. Carroll farm. It has been averaging 15 bbls. a day for the past five days. This is much better than the average for wells in this county. Later the well will be drilled through the 30-foot sand.

Greene County

In Perry Township, Greene County, the Carnegie Natural Gas Co. has completed at a total depth of 3,208 feet a test on the A. D. Jones farm. It is a light gasser. In the same township, the South Penn Oil Co. has a 10-bbl. pumper in the Big Injun sand at No. 3 on the Ernest Headler farm. In Green Township, the Independent Oil & Gas Co. has completed in the same formation a second test on the I. P. Marier farm. It is a fair gas well. In Morris district, the Consumers Fuel Co. gave its No. 4 on the James S. Rutan farm a shot and increased its production from 35 to 225 bbls. a day.

In Aleppo Township, Greene County, the Manufacturers Light & Heat Co. has a fair gasser at a test on the Flora and Samuel Rutan farm. In Richhill Township, Wasmuth, Callihan & Co. have a gasser in the Salt sand at a test on the Mrs. Mack Goodwin farm. In Greene Township, the Carnegie Natural Gas Co. has a gasser in the Elizabeth sand at No. 3 on the J. C. Morris farm. In Whitley Township, the same company's test on the A. H. Johns farm is a gasser in the Bayard sand.

MICHIGAN FIELDS

(Continued from Page 68)

this season's developments may be more important than those that preceded it. In the first place there will be a continuation on a large scale of drilling of the Berea Pool, at present the backbone of the field; and a material increase during the summer of the number of Berea sand producers, now approximately 200.

Drilling in the Saginaw Field has in large part settled down to a steady operation of a comparatively small number of concerns. Where there have been at one time or another more than 60 persons, groups or companies drilling in the field, there are at present less than half that number of companies that are at all active in new work. Many of the early wells were drilled by groups or individuals that drilled one, two or three wells, and then stopped, merely pumping the wells they have. These groups have largely stopped their work, and the lion's share of the present drilling is in the hands of a few concerns.

The present interesting development has been the extension of drilling to the east bank of the Saginaw River, near or actually in the east side business district. Two wells have been finished in the Berea, and six more are in various stages of advancement. All but one are north of Genesee Avenue, extending as far north as Wicker Brothers' plant, but one, that of Morley Brothers, is being drilled about half a block south of the river bridge. How far this east side drilling will be extended is one of the things that the next few months must determine.

In the Saginaw Field itself, deeper tests than the Berea sand are matters of intense interest to oil men. The Saginaw sand has been disappointing. Though the Sun Oil Co. got a well on the Ferdinand Stelzreide farm, at the north edge of Berea production, that for a short period made nearly 500 bbls. a day from this formation, it has slumped badly and is now doing only about 15 bbls. And while there have been Saginaw sand wells in other locations, there also have been a good many dry holes sandwiched in with them, and the sum total of Saginaw sand drilling experience indicates that this formation is extremely spotty and uncertain. There are hints for better things from the Dundee sand, about 1,000 feet below the Berea. Two wells in the Berea Pool have been drilled to the Dundee with showings of oil, but mishaps have hampered both operators and the field as a whole is awaiting more definite information as to what the Dundee holds. But a good many oil men consider it decidedly promising.

Field Notes

Fordney Petroleum Co. has a rig in for a well on property of the Eastwood Glass Co., on the east side of North Water Street, between Fitzhugh and Carroll Streets, on the east side of the Saginaw River. The well is in the rear of the Eastwood plant.

Atlas Oil Co. set a string of 725 feet of 8-inch in its well at Davenport Street and the Michigan Central tracks.

William M. Bradley & Son are drilling their well on the Henning Sausage Co. property on the east bank of the river, near Fitzhugh Street. Morley Brothers have started on the same side of the river in the rear of the company's electrical shop on South Water Street, between Genesee and Federal Avenues.

The wildcat of the Robert Gage Coal Co., near Tawas, in Iosco County, Michigan, is reported at a depth of 2,700 feet with no oil showings yet, but expected to go to the Dundee sand.

SOUTHWEST WILDCATS

(Continued from Page 54)

and 363 feet to west line, is drilling at 1,804 feet, having tested dry.

Webb County

Rio Grande Oil Co.'s No. 1 Urbahn, Santo Tomas tract, 10,000 feet to south line and 20,000 feet to east line, has let contract to Cezeaux & Putman to resume drilling at 1,600 feet. O. W. Killam's No. 1 Billings, SE NW, Survey 43, located 150 feet to south line and 750 feet to west line, is drilling at 3,750 feet. Tubbs & Wright's No. 1 Reiser, Survey 1,617, Block 14, is drilling shallow test. W. O. Wheatley's No. 3 Kruger, Survey 1,570, Block 4, is location, 640 feet to north line and 421 feet to east line.

Starr County

Commonwealth Oil Co.'s No. 1 Garcia, Survey 538, located 2,722 feet to south line and 2,102 feet to west line, is drilling at 1,080 feet. Southern Exploration's No. 2 Russell, Share 172-B, Porcion 69, at 150 feet to north line and 950 feet to west line, is waiting orders. Milham Corp.'s No. 2 Salinas, Porcion 111, SE cor., is drilling at 4,279 feet. Alfred M. Letzeich's No. 2 H. Gonzales, Survey 339, Block M, located 339 feet to east line and 2,040 feet to south line, is drilling.

Zapata County

H. H. Galbraith's No. 1 M. A. Hirsch, Survey 595, NE cor., is location. Buffalo-Erie's No. 1 Burtrand, Survey 627, is location 3,239 feet to northeast lines and 500 feet to northwest lines. E. K. Bateman's No. 2 Vela, Block 4, located 675 feet to northwest lines and 417 feet to northeast lines, at 124 feet, has set and cemented surface casing. Roxana Petroleum Corp.'s No. 1 E. Lopez is drilling at 270 feet. J. H. Winch's No. 1 Bustamente, Share 10, Block 8, located 150 feet to northeast and southeast lines, is drilling at 1,560 feet. The Texas Company's No. 6 Jennings, Cerrito Blanco grant, 7,200 feet to northwest lines and 16,800 feet to southwest lines, is drilling at 300 feet. Killam-Duggan's No. 1 R. B. Cuellar, Cerrito Blanco grant, 150 feet to northwest and southwest lines of northeast 1,172 acres, at 1,342 feet, tested salt water. Duke and others' No. 3 Martinez, Block 22, Duke-Langford Subdivision, Charco Redondo grant, 150 feet to southeast and southwest lines, is rigging up. Harlingen Oil & Gas Co.'s No. 5 Martinez, at 1,021 feet, is testing.

SAN ANTONIO DISTRICT

Bexar County

Allen Burnam's No. 1 Ward, south of Martinez, on the R. A. Ward 164-acre tract, located 600 feet to north line and 2,400 feet to west line, has derrick up and moving in rig. A. R. Beal, trustee's No. 1-A Ackerman, Survey 133½, is drilling at 625 feet.

Bee County

Red Ant Oil & Gas Co.'s No. 1 Perry and Chestnut, 7 miles west of Pettus, (formerly W. S. Poole's No. 1 Billingsley), has material for derrick on ground. D. Hewitt's No. 1 G. A. Ray, 1½ miles west of Pettus, is drilling. Nichols & White's No. 1 Hicks, Block 19, NW cor. Hicks-Ball Survey, is shut down at 1,200 feet.

Caldwell County

E. F. Smith's No. 5 San Marcos River, is location north of No. 4. Sutton & Smith's No. 2 Carter, Green Hinde Survey, is location 300 feet east of No. 1; No. 1 J. L. New, James Hindes Survey, 150 feet to west line and 600 feet to south line, has 112-foot derrick up. Kuhn & Armstrong's No. 1 Thomas, drilled in the early days of Lytton Springs, is standing 400 feet in oil and pump is being put on test to make test, and rig and derrick is being moved to location for No. 2, 600 feet to the southeast; Calco Petroleum Co.'s No. 2 Thomas, located 600 feet southeast of Kuhn & Armstrong's No. 1 Thomas, is having derrick and rig skidded over. Detex Oil Co.'s No. 1 Hardeman, 4 miles north of Luling, is drilling at 2,500 feet. Joe Bruner-Doctor Ritchie's No. 1 W. F. Davis, Salt flats, is standing at 2,538 feet. Sutton & Smith's No. 1 Carter, G. Hinde Survey, is fishing at 2,597 feet for 8-inch.

DeWitt County

Eduoard Raymond's No. 1 Boldt, James Lasater Survey, W. R. Boldt 250-acre tract, 800 feet to south line and 1,125 varas to east line, has been delayed spudding in by work on titles. G. O. Williams and O. L. Gates' No. 1 Oscar Gohmert, G. W. Brooks league, 175 feet to north line and 300 feet to east line, has set surface casing at 100 feet. Empire Southern Oil Co.'s No. 2 Smith, Survey 3, located three-quarters of a mile west of No. 1, is at 800 feet and has moved in new boiler. McNeil & Matthews' No. 1 A. D. Kaiser, A. Dillard Survey, located 1,508 feet to NW cor., is shut down at 2,600 feet. Yoro Development Co.'s No. 1 Tully, located across railroad tracks, 1 mile from No. 1 Tom Burns, has been spudded in and shut down.

Dimmitt County

Humble Oil & Refining Co.'s No. 1 City National Bank, Survey 654, located 700 feet to north line and 2,000 feet to east line, is drilling at 2,425 feet, corrected depth.

Frio County

P. A. Neilan's No. 1 Blackaller, James Gouley Survey, is still fishing at 3,005 feet for drill stem and tools.

Fayette County

LaFayette Oil Co.'s No. 1 August Marquardt, J. R. Phillips Survey, 976 feet to northwest lines and 400 feet to southwest lines, is drilling. Magnolia Petroleum Co. has made location for a wildcat test, 9 miles northwest of LaGrange, and is moving in rig, and building derrick.

Guadalupe County

H. H. Temple's No. 1 McAllister, Edward Kellett Survey, 450 feet to northeast lines and 1,420 feet to northwest lines, at 750 feet, is moving in large rotary rig. F. A. Lain's No. 1 F. C. Weinert, W. K. Estell Survey, 150 feet CNL, is drilling at 2,700 feet.

Hays County

J. E. Rodgers' No. 1 Hohenburg, 2½ miles east of San Marcos, at Martindale, is underreaming at 1,120 feet.

Jackson County

Houston Gulf Gas Co.'s No. 1 White, Gale Survey, center of east 20 acres, is drilling at 2,400 feet and expects to complete at 2,500 feet.

Kerr County

Walker-Van Duyn's No. 1 W. B. Leigh, Survey 38, located 500 feet north of river and 150 feet south of railroad, is fishing again at 2,250 feet.

Kinney County

W. A. Stephens and others' No. 1 Jim Clamp, Section 1,492, Survey 346, located 5,362 feet to west line and 5,674 feet to south line, is in hard lime at 805 feet. Havelin Oil Co.'s No. 1 Weatherby, Section 21, Block 5, is shut down at 4,330 feet in brown sandy shale for repairs on engine.

Lavaca County

Steinman Brothers' No. 2 Steinman (fee), located 4 miles southeast of Yoakum and 100 yards from No. 1, has been abandoned at 3,233 feet.

Lee County

Bowers and others' No. 1 Brenbaum, 2 miles east of Monheim and 200 feet to NW cor. of lease, is drilling at 1,473 feet. M. O. Ricketts and others' No. 1 Sanders, Joseph Maxmillian league, 250 feet to SE cor., is shut down at 800 feet.

Live Oak County

Stovall & Kelly's No. 1 Stewart, William J. Cannon Survey, is location 200 feet west of Nueces River and 200 feet south of Lagarto Creek. Delta Oil Co.'s No. 1 B. McNeil, Jame Curry Survey, 4,000 feet to NE cor., is shut down at 530 feet. R. P. Lightfoot's No. 1 F. W. Thomas, northwest of Coquat wells, is making test at 550 feet. Simms Oil Co.'s No. 4 Sartain, Simms tract, western edge of county, is making test at 1,700 feet. J. W. Walton's No. 1 Roberts, west of Three Rivers, is standing at 1,837 feet.

Medina County

Fennell & Williams' No. 2 John Fohn Survey 115, east 100 acres, is setting

casing at 1,875 feet to make test, report of abandonment in error. C. W. Simpson's No. 1 Blocker, Survey 20, located 150 feet to north line and 305 feet to west line, at 917 feet, is testing as test had gas showing. Witherspoon Oil Co.'s No. 2 Redus, Survey 92, tested salt water at 1,122 feet and is plugging back. R. P. O'Brien's No. 1 J. P. Nixon, Survey 531, is going on pump at 1,007 feet. J. A. Swayze's No. 1 Oeffingers, Survey 129, Block 22, is shut down at 300 feet. Cecil Switzer's No. 1 Zerr, Survey 459, is to set casing at 2,760 feet to shut off water. California-Medina's No. 1 Rothe, is pulling casing at 3,119 feet in preparation to drilling deeper.

Maverick County

Ryan Consolidated Petroleum Co.'s No. 1 Indio, Survey 14, center, is standing at 1,200 feet waiting on orders. Johnstone & Hout's No. 1 Whipff, 9 miles from Eagle Pass, is shut down at 1,220 feet. Rycade Oil Co.'s No. 1 Chittim is fishing at 5,592 feet; No. 2 Sullivan at 3,832 feet, had casing collapse.

McMullen County

E. R. Marts' No. 3 Farmers Life, Survey south of No. 56, is location 2,000 feet to south line and 4,000 feet to east line; No. 8 Poitevent, Survey 56, is location 1,250 feet to south line and 150 feet to southwest lines. C. H. Atherton is making location for No. 1 Lark. R. L. Taylor's No. 2 Shiner, Survey 14, located 150 feet to SW cor., is location with drilling to start soon. Nelson & Woods No. 1 Shiner, Survey 48, Block 74, located 1,000 varas to east line and 350 varas to south line, is shut down at 783 feet. George Pickett's No. 1 Jacob, Survey 7, located 660 feet CNL, is drilling at 2,960 feet in hard gray sandstone, probably Mount Selma, with some gas at 760 feet. Dodson and others' No. 11 Franklin, SW Survey 31, is shut down at 1,100 feet. Houston Gulf Gas Co.'s No. 5 Jacob, J. Rees Survey, 600 feet to north line and 2,500 feet to west line, is standing at 904 feet. George M. Ball's No. 1 Kuykendall, Block 7, located 300 feet to south line and 600 feet to east line, is standing at 1,390 feet.

San Patricio County

W. L. Pearson's No. 1 Moore, Block 3, Roos Survey, 750 feet northwest of No. B-3, is drilling at 2,143 feet. F. S. Smiley's No. 1 T. E. Wilson, one fourth mile northwest of Angelita, is location, derrick blew down recently. Huber & Crawford's No. 1 Mathis, Delgavo Survey, Block 17 located 300 feet to northwest lines and 2,500 feet to southwest lines, is shut down at 2,516 feet. John Sigmund's No. 7 McCampbell is shut down to change crews.

Victoria County

R. M. Talbott's No. 1 J. K. Reeves Estate, located 2,000 feet to west line of estate, is shut down at 750 feet.

Val Verde County

Magnolia Petroleum Co.'s No. 1 Whitehead, Survey 81, located 1,900 feet to west line and 900 feet to south line, is waiting on material. Douglas Oil Co.'s No. 1 Sellers, Section 82, Block A, at 2,940 feet had rig burned down. Hiawatha Oil Co.'s No. 1 Sellers, Section 1,031, Block A, total depth 2,600 feet, is straightreaming at 1,900 feet on account of crooked hole. Crusoe Williams' No. 1 Holman, section 5, Block N., is fishing at 2,920 feet. O. O. Owens and others' No. 1 Henry Mills, Section 145, is straightening crooked hole at 2,460 feet in black shale. Independent Operators' No. 1 Whitehead, SE SE, Section 30, Block 4, is shut down at 3,900 feet in lime. A. Blume and others' No. 1 Moore, Section 183, located 330 feet to north line and 1,320 feet to west line, is shut down at 2,676 feet. East Del Rio Oil Co.'s No. 1 Russell, east corner of Section 183, is shut down at 3,140 feet.

Wilson County

Thomas and others' No. 1 August Haese, Survey 124, located 300 feet to NE cor., is drilling.

Williamson County

Watercress Oil Co.'s No. 1 Fowler, D. D. Fowler lease, 6 miles west of Georgetown, is moving in rig. Fritz Fuchs' No. 1 John Kubricek, P. J. Mahon Survey, 250 feet to north line and 300 feet to east line, is rigging up.

Zavala County

B. F. Thompson's No. 1 West, West ranch, northern part of the county, has 112-foot derrick up and moving in rig. J. G. Pundt's No. 1 West, east of Uvalde on the Batesville road, has been spudded in.

CALIFORNIA FIELDS

(Continued from Page 64)

in Kern County since the Midway Gas Co. laid its line from Grapevine to Monolith last fall. The Midway gas line involved the laying of 37 miles of pipe under adverse conditions due to the broken nature of the mountains traversed.

Seal Beach

The production curve at Seal Beach, which has again swung upward, will probably continue rising for another two weeks if the Selover zone at Alamitos Heights holds up after completion of some of the many wells which are after the deeper penetration now available. The Pan American and Petroleum Securities are not losing any time in taking advantage of the thicker sand found in the town lot area and as a result these two companies have started deepening 15 drillers and former producers from 4,600 feet to around the 4,850-foot level. In addition to this number, the Doheny interests have 10 additional drilling projects approaching the 4,600-foot mark, most of which will take all the sand that is available. These two companies alone should account for at least 10,000 bbls. of new production during the next three weeks if the Selover zone is as productive as the first few completions indicate. A check of the Pan American's present activities indicates the probable completion of 10 wells during the next seven days. The Pan American's current completions include No. 1 Kellas, a 302-bbl. pumper from 4,795 feet. This is the smallest well which the Pan American has completed up to the present but because of its position on the structure no change will be made in its status pending further developments.

The two Gettys, George F. and Paul J., are also making a bid for deep production and both should finish another well or two within 10 days. George F. Getty has just recompleted No. 2 Alamitos after redrilling and deepening it from 4,683 feet to 4,870 feet. When returned to production this well started off flowing 2,445 bbls. of exceptionally clean 27.6 gravity oil daily. Paul Getty recompleted No. 2 Cleaver after deepening it from 4,705 feet to 4,852 feet and it was brought back flowing 1,160 bbls. of clean 27.1 gravity oil daily. Reports from the field indicate that some water trouble developed late yesterday and in view of the fact that the well has heretofore produced clean oil, some are inclined to believe bottom water has been encountered. Should this assumption prove correct, the Selover zone at Alamitos Heights will be somewhat limited in both thickness and area. Because of the importance of the larger penetration now being taken, operators will watch developments with considerable interest for the first indication of bottom water or lensing out of this sand will tell the whole story. One of E. J. Miley's producers has also shown symptoms of bottom water, although this has not been definitely determined.

Deepening Wells

The California Petroleum deepened its No. 2 Alamitos immediately after the discovery of the Pan American and this well was recompleted during the early part of the week and brought back flowing 1,925 bbls. of clean 27.6 gravity oil daily after being carried down from 4,669 feet to 4,854 feet. The Calpet is deepening four other wells for larger penetration in the oil sand and will carry No. 1 Lovell down as a conclusive deep test. The Marland Oil Co., discoverer of the Seal Beach Field, is pursuing a rather intensive drilling campaign, a large part of which is obligatory due to an offsetting program necessary to protect its acreage from drainage by operators drilling in the town lot area. The company's drilling operations during the past week resulted in the completion of several new wells on the Selover lease and the recompletion of three others which have been temporarily off production. On the Selover lease, the Marland brought in No. 11 doing 1,225 bbls. of clean 26.4 gravity oil daily from 4,849 feet. No. 12 Selover started off doing 1,590 bbls. of clean 26.7 gravity oil daily from 4,869 feet. No. 17 Bixby, a recent completion at 4,500 feet, is doing 1,295 bbls. of clean 24.1 gravity oil daily from the Bixby zone. Operators in the Seal Beach Field are beginning to use compressors in order to effect maximum production and the Marland will follow out this procedure with No. 15 Bixby, which has been finished at 4,425 feet, but has so far failed to come up to expectations.

The California Eastern Oil Co., after getting off to a late start, has several potential producers nearing completion and this company should be in a position to substantially increase its production if the Selover zone holds up. During the early part of the current week the company brought in No. 1 Horowitz doing 1,445 bbls. from 4,826 feet. The oil from this new well, which is exceptionally clean and tests 27.2 degrees, is flowing through a three-quarter inch bean under a pressure of 700 pounds. The Travis Drilling Co. finished its first producer in the town lot area of the Seal Beach Field a few days ago but results were far from satisfactory. The company's new well, No. 1 Reinhold, came in doing 360 bbls. of clean 26.8 gravity oil daily from 4,760 feet. The General Petroleum's deep test, No. 7 Wasem, has just passed the 5,200-foot level and, while the outlook is rather unfavorable, another several hundred feet may show a change for the better. The Associated cored an exceptionally rich oil sand in No. 31 Bryant at 4,579 feet and this well should be on production in the very near future. These additional wells on the Hellman property should also be finished shortly. A check of the operations of the various independent companies and individuals operating in the town lot area reveals that something like 10 new producers can be anticipated during the next two weeks.

Long Beach

There were no new wells finished in the Long Beach Field but there were several recompletions listed. The Rio Grande Oil Co. returned No. 1 Coffin to production after redrilling and deepening it from 4,650 feet to the deep zone at 5,502 feet. Upon being recompleted it started off flowing 750 bbls. of clean 29.2 gravity oil daily. The Liberty Oil Syndicate's No. 1-A Harlow was recompleted after being plugged back from 3,602 feet to 3,368 feet, at which depth it was put on the beam. The initial pumping was 150 bbls. of 21.2 gravity oil daily. Harry Failing's No. 1 Finney was returned to production pumping 115 bbls. of 23.4 gravity oil daily after being redrilled and deepened to 4,907 feet. The Shell should be in a position to make a bid for deep production on the Cresson lease within a few days as No. 7 cored a rather rich oil sand at 5,340 feet and preparations are being made for an early test. The company has four other deep projects under way on this lease but since they are all above the 4,000-foot level, it will be three or four weeks before they reach the projected depth at which production is anticipated. The California Petroleum expects to complete No. 1 Flower State in the deep zone soon, although the outlook is not any too favorable for big production.

Huntington Beach

The California Fish and Game Commission has ordered operators in the Huntington Beach Field to take immediate steps to stop the pollution of coast waters or face injunction suits which will force them to suspend operations until adequate steps are taken to prevent the drainage of drilling fluid and waste oil into the Pacific Ocean. John Spencer, chief of the hydraulic division of the California Fish and Game Commission, is in charge of the activities designed to prevent pollution of navigable waters and as a result of the investigation which is nearing completion evidence will be submitted to the commission's legal department for the preparation of injunction suits. Conditions in this field should not be as difficult to cope with as those prevailing at Long Beach and, since it has only been a case of passive resistance in the past, Huntington Beach operators will no doubt take the necessary steps at once. The Standard has expended approximately $100,000 in building a concrete retaining wall to prevent drainage into the coast waters and for this reason it is not likely that this concern is open to criticism.

The Concord Oil Association finished its No. 1 Extension at 4,363 feet and the well was brought in flowing 194 bbls. of 24.3 gravity oil daily. The San Martinez Oil Co. made a preliminary production test of its outpost on Ninth Street but has not yet released any information on the results secured from 5,170 feet.

Richfield

There were three new wells finished in the Richfield district and two completions chalked up at Montebello. In the former field the Continental Oil Co. brought in No. 5 Pyne flowing 455 bbls. of 25.6 gravity oil daily from 4,401 feet, the hole being finished with a 4½-inch oil string. The Union's No. 14 L. G. was somewhat of a disappointment at 2,966 feet, as it only started off doing 65 bbls. per day. This company, however, has eight other drilling projects in this field in addition to three more at Fullerton. The Superior Oil Co.'s No. 1 Etchandy has just been passed for production at 4,555 feet and it looks good for approximately 150 bbls. of settled production. The General Petroleum's No. 4 Mullin at Richfield gives evidence of resulting in good production as the oil sand logged at 4,209 feet looks quite promising. On the Pedeco property, Nos. 1 and 2 have just passed the 1,200-foot level with No. 10 Thompson a few hundred feet deeper. The Standard staked a new location on the recently acquired Yorba Linda Water Co.'s lease and rig construction will get under way soon. The Chanslor-Canfield Midway Oil Co. has not yet picked up the pay in either No. 7 or No. 8 on the Richfield lease but should do so shortly as both wells are in proven territory. The California Petroleum Corp. should also list two or three new wells for completion in this area shortly.

Montebello

The St. Helens Petroleum completed No. 14 Monterey in the Montebello Field at 4,328 feet and this new well started off pumping 295 bbls. daily. Drilling has just been resumed in No. 15 Monterey following the landing of a string of 8¼-inch at 4,287 feet. The St. Helens has some 15 or 20 drilling sites available in this field for future work but the company is wisely limiting its drilling operations pending the return of normal conditions and incidentally higher prices for crude. The Standard's No. 1 Whitehead in the western end of the Montebello Field was an exceptionally small pumper from 5,165 feet and because of the small production secured, 40 bbls. daily, further development work has received a little setback. No. 1 Stocker-Merced, located on property recently acquired by the Standard, is going ahead in a hard gray sand at 1,390 feet.

The Shell is not doing any development work in the Montebello Field but is concentrating its operations in the Brea Olinda, or Fullerton Field, where the company is running five strings of tools. No. 40 Columbia, at 6,050 feet, is scheduled to be a conclusive deep test and it is understood that the Shell will carry this well down to below the 7,500-foot level if it is possible to do so. The decision to engage in deep drilling by the Shell recalls the attempt of the Chanslor-Canfield Midway Oil Co. to develop deep production in No. 96 Olinda, which holds all records for either rotary or cable tool drilling. This well was carried down to 8,201 feet in a vain search for production. The Birch Oil Co. should list another one of its periodical completions in the Brea Olinda Field in the near future as its No. 13-A recently passed the 5,200-foot level. The Fullerton Oil Co.'s No. 22 should follow this well into production some time later.

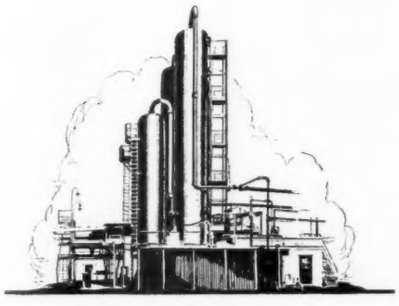
Kern River

Operators in the Kern River Field have just closed a rather busy week during which period six new wells were actually completed, in addition to several others which are just about ready to go on the beam. George F. Getty finished two new producers out on the Kern front

THE CROSS CRACKING PROCESS

CRACKING IN LIQUID PHASE
assures greater once-through yields

By maintaining the requisite pressure and temperature in the cracking chamber to hold the oil substantially in the liquid phase until the cracking reaction is completed, the CROSS PROCESS assures the greatest possible once-through conversion. Vaporization and its chilling or retarding effect is minimized.



KELLOGG

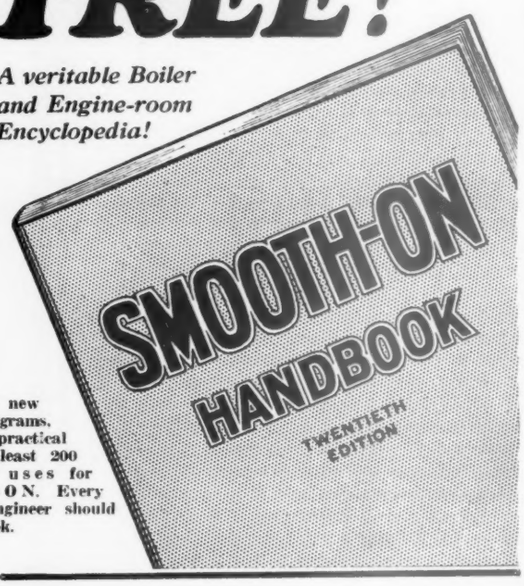
CROSS CRACKING PLANTS—BUBBLE TOWERS—PIPE STILLS—HEAT EXCHANGERS—GRAY TREATING TOWERS—TREATING PLANTS

THE M. W. KELLOGG CO., 7 DEY STREET — NEW YORK

KANSAS CITY, MO., 700 BALTIMORE AVE. — SAN FRANCISCO, CAL., 444 MARKET ST., LOS ANGELES, CAL., 1019 HELLMAN BANK BLDG.

FREE!

A veritable Boiler and Engine-room Encyclopedia!



136 pages of new data—193 diagrams, pictures and practical hints on at least 200 different uses for SMOOTH-ON. Every progressive engineer should have this book.

"WORTH its weight in gold" is a mild expression about the value of this book because the first hint you apply from its pages may save you more than that amount.

These subjects are discussed in detail:

Repairing cracks in boiler shells, tube sheets and headers—Making tight joints and stopping leaks at seams, rivets, and manhole covers—Restoring contact faces of corroded flanges—Repairing leaks or cracks in engine and pump cylinders—Making tight new and stopping leakage at old screwed or flanged joints—Stopping leaks in cracked fittings, valve bodies, centrifugal pump shells, fuel economizer headers, feed heaters, separators, condensers, steam kettles, etc.—Making water and oil-proof machine foundations, floors, wheel pits, sumps, cooling ponds, filtration beds, underground storage tanks, etc.

You owe it to yourself to have this valuable information at hand for quick reference, and even though you are already familiar with SMOOTH-ON, you will need this book to post yourself on the newest applications.

All you need to do to get your copy is—

Mail this coupon

SMOOTH-ON MFG. CO.
Dept. 66, 570 Communipaw Ave., Jersey City, N. J.

Please send a copy of the SMOOTH-ON Handbook, 20th Edition.

Name .....

Address .....

.....

6-16-27

SMOOTH-ON

and incidentally increased his daily production 260 bbls. No. 19 Tegeler was a 140-bbl. pumper from 2,435 feet, while No. 1 Lehnhardt was put on the beam and started off pumping 120 bbls. from 2,082 feet. The oil in each case tests 14.1 degrees and shows a cut of approximately 2 per cent. The Standard finished a good well in Section 27-28-27 and followed this up a short time later by bringing in another new producer in Section 15-28-27. The former was No. 8, which came in pumping 235 bbls. daily from 2,363 feet, while the latter was No. 5, a 130-bbl. pumper from 2,196 feet. No. 7 in Section 15-28 27, has just been finished and it will be put on the beam within a few days. The Chanslor-Canfield Midway Oil Co.'s No. 4 in Section 23-28-27 started off pumping 230 bbls. daily from 2,340 feet, the hole being finished with an 8⅝-inch oil string carrying 290 feet of shop-perforated. No. 1 Whetmore of the General Petroleum in Section 14-28-27, resulted in a 110-bbl. pumper from 2,037 feet. All four of these operators have additional wells nearing completion. Drilling operations in the Mount Poso Field, some 15 miles northwest of Kern River, are being held down to a minimum due to the lack of adequate pipe line facilities.

Round Mountain

All evidences point to the fact that the newly discovered field at Round Mountain, approximately 16 miles northeast of Bakersfield, will be a second Mount Poso in that the oil produced will be of a rather low grade testing around 16 or 17 degrees A. P. I. The Round Mountain Field has an advantage over the Mount Poso area, however, as it has shown a somewhat higher gas pressure. The discovery well of the Elbe Oil Co. in the former district is showing a gas pressure ranging between 225 and 250 pounds.

Geologists and petroleum engineers have come to the conclusion that the Elbe well at Round Mountain is producing from a sand similar to the so-called Vedder zone at Mount Poso and hence nothing big is anticipated. First reports indicated that the Elbe had picked up a light oil with a fairly high gasoline content but this upper sand failed to result in commercial production and deeper drilling resulted in the development of a zone yielding heavy oil. The probable extent of the Round Mountain Field is still conjectural but the several new wells scheduled to be started by the Elbe Oil Co. in the near future should throw considerable light on the subject. Practically all acreage within a radius of 2 miles of the discovery well has been tied up for some time but notwithstanding this many companies have scouts in the field looking for available acreage. Frank Grimes recently leased a 160-acre tract about 3 miles northwest of the Elbe well and a derrick is in course of construction.

Northern California Wildcats

It is rather surprising to note that wildcat operations are continuing unabated regardless of the present heavy overproduction situation and no letup is in sight. This prospecting work, which is statewide in character, may possibly prevent an early return to normalcy, for if another new prolific field should be opened up at this time it would undoubtedly have a very demoralizing affect on both producers and refiners. All progressive operations, of course, are looking to the future and every one is desirous of building up as large a reserve as possible in order to take care of requirements after the present flush condition has become a thing of the past. The immediate effect on production, however, may prove rather disastrous unless wildcatters limit their operations to large acreage and thus preclude anything but normal development.

The Chanslor-Canfield Midway Oil Co., discoverer of the Torrance Field, has set a good example along this line by limiting its operations to areas in which large holdings can be blocked out. This company has two rather promising-looking wildcats, both of which may bear watching during the course of the next 30 days. The most important of these is No. 1-B Hobson in Ventura County almost due west of the prolific Ventura Avenue anticline. Good showings of oil and gas were logged in this well at 4,340 feet and the fact that a string of pipe has been landed and cemented indicates that this wildcat has unusual possibilities. The Chanslor-Canfield Midway Oil Co. has drilled two wells in this immediate area and preparations are being made to start two more tests. One of the company's new projects will be drilled but a short distance from the beach on a state prospecting tidewater permit which covers an area along the ocean front of approximately 2,500 feet and extends out into the open sea a distance of about a mile.

The second new test under contemplation will be drilled on a United States Government permit covering 80 acres a little less than a mile northwest of the company's No. 1-B Hobson, which is standing cemented as a result of favorable showings of oil and gas. Should the Chanslor-Canfield Midway interests open up a new field in this area it will more than likely be a highly productive one as conditions are somewhat similar to those existing at Ventura Avenue. As a matter of fact, the company is working on the assumption that the Ventura Avenue anticline comes up again in the section now being prospected.

Fair Indications

The Chanslor-Canfield Midway Oil Co.'s other promising wildcat is No. 1 Quinn near Delano in Kern County. This test does not have the possibilities of the company's wildcat in Ventura County but it is nevertheless interesting because of the fact that it has shown fair indications of oil and gas. The company has around 5,000 acres under lease in this section and hence the showings logged in No. 1 Quinn at 1,723 feet will be tested out very thoroughly. There were no further developments of interest in the Kettleman Hills area during the past week, although the General Petroleum is contemplating the drilling of a fourth test in this section. No. 1 Burbank, which the company drilled in Section 30-23-19, is capable of pumping 25 bbls. per day but it, like the Bolsa Chica's wildcat nearby, is being bothered with water trouble which prevents the production of clean pipe line oil. For this reason the company will probably continue further work in the hope of solving this difficult problem. The Superior Oil Co. is abandoning its No. 1 Pena near Piru in Ventura County as a dry hole at 5,030 feet. The Bellview Oil Syndicate is also abandoning a prospect hole in the Piru section of Ventura County but in this case the hole was only carried down to 3,740 feet. The Temescal Petroleum is abandoning No. 4 B. & L., located on E. L. Doheny's 10,000-acre Temescal ranch at Piru because of the unfavorable outlook at 2,507 feet. This hole is across the creek from the company's first three successful producers, which are now pumping around 100 bbls. each, and core samples indicate that it is off the Temescal structure.

Southern California Wildcats

The California Eastern Oil Co. has only had a few minor showings in its wildcat at Potrero and the outlook therefore is not any too favorable. At any rate, the industry can now rest easy so far as the town lot section of this district is concerned since the drilling of two dry holes in the town lot area precludes any intensive work as they have limited this section to the south. The Associated has not yet resumed work in its No. 1 Cypress, which resulted in considerable subsequent work, but is going ahead in No. 1 Johnson, a second test in this area at 3,720 feet.

Oscar P. Schmidt has staked a location north of the Standard Oil Co.'s No. Kraemer lease at Richfield and it is understood that early work is contemplated. The Shell is making fairly good progress with its two southern California wildcats, one at Placentia and the other in the San Fernado Valley, but the Standard, on the other hand, is only batting 50 per cent since its projected test at Palms has been held up by injunction proceedings instituted by adjacent property holders. Work at Olive, however, is going ahead on schedule and the Standard will spud this well in shortly.

George F. Getty's No. 1 Tubbs, a rather interesting wildcat near Rivera, is rotating ahead in a hard sandy shale at 3,060 feet. This property is being developed on a sublease from the Marland Oil

Co. Jim O'Donnell's wildcat out on Harbor Boulevard opposite the tank farm of the California Eastern Oil Co. near Julian City, is making splendid footage and in view of the progress made to date an early test is likely, as the projected depth at which production is anticipated should be reached in the near future. It was reported down 4,500 feet late yesterday afternoon.

MEXICAN FIELDS

(Continued from Page 50)

in brown lime at 2,365 feet; No. 3 Vonphul is in gray lime at 1,475 feet. National Lines' No. 60 Conteca is in gray clay at 1,360 feet; its No. 61 is in brown lime at 2,577 feet. Kern Mex Oil Fields' No. 3 Clarin is in brown lime at 1,945 feet; No. 4 Salinas is in gray lime at 1,725 feet; No. 7 is in gray lime at 2,050 feet; No. 17 is in gray shale at 850 feet; Nos. 18 and 19 have each cemented 8-inch in gray lime at 1,740 and 1,743 feet, respectively; No. 22 is rigged, waiting for permit. Mexican Gulf Oil Co.'s No. 28 Salinas is in gray and brown lime at 1,940 feet; No. 49 is in gray shale at 1,220 feet.

Northern Miscellany

Among the miscellaneous operations in the northern fields consider the following: In the Hacienda Limon, Cia. Pet. Franco Espanola (Marland) No. 63-A Limon is in shale at 1,200 feet; No. 90 is in shale and lime at 1,635 feet; No. 101 is in gray lime at 1,450 feet, and three derricks are up over locations.

In the Corcovado: Rich Mex Oil Co.'s No. 9, Lot D, is ready to spud, and it is moving in for two more rigs. Rodolpho Sanchez and others' No. 2, Lot 1 Garruche, is in shale around 500 feet. International Petroleum Co.'s No. 17, Lot 6, is in gray lime at 1,710 feet.

American International Petroleum Co.'s No. 67 Los Esteros is in gray and brown lime at 1,724 feet. Mexican Fuel Oil Co.'s Nos. 7 and 8, Lot 6 Tamboyoche (Topila) have derricks up and are waiting permits. The Texas Company's No. 5, Lot 4 Paciencia de Aguacato, is drilled 708 feet, shale, and is waiting for casing. National Oil Co.'s No. 14, Lot 75 Quebrache, is rigging. Rich Mex Oil Co.'s No. 13, Lot 26 Altamira, is in gray shale at 700 feet; and its No. 15, Lot 29, is a derrick. National Lines' No. 144 Panuco is in brown lime at 2,335 feet; its No. 140 Champayan is in gray and brown lime at 2,000 feet.

South Fields

In the south fields operations are as follows: Huasteca Petroleum Co.'s No. 98 Tierra Blanca is in broken lime at 2,120 feet. Millan and others' No. 4, Lot 191 Amatlan, is in hard gray shale at 1,930 feet. Mexican Eagle Oil Co.'s No. 34 Laguna de Tamiahua is in sandy shale at 2,600 feet; its No. 10 San Diego has cemented 6-inch in sandy shale at 1,000 feet. Mordelo Vincent No. 9, Lot 8 Tepetate is ready to spud.

SOUTHWEST TEXAS

(Continued from Page 54)

cated 150 feet to north line and 400 feet to west line, at 200 feet is shut down while crew is working on No. 2 Nixon trying to bring it under control. Western Gas & Fuel Co. and C. E. Lange's No. 6 Adams is location in Durst Survey, 1,550 feet northwest of No. 5.

Refugio Gas Field—Refugio

Houston Oil Co.'s No. 10 Fannie Heard, Refugio tract, 592 feet northeast of No. 9, is standing at 2,020 feet with casing set ready to drill in; No. A-2 Rooke, T. Mullen Survey, 677 feet to north line and 700 feet to east line, has set surface casing; Pratt-Hewitt's No. 5 Rooke, at 2,400 feet is preparing to rig up over old hole to complete at that depth or to drill deeper. Houston Gulf Gas Co.'s No. 6 Lambert, at 1,165 feet blew out with only surface casing in hole and is a fair sized gas well and has been turned into the line; No. 7 Lambert, has been spudded in; No. 2 Lambert is drilling at 675 feet; Moody No. 1 Wilson-Heard is drilling deeper after testing salt water at 1,920 feet. William F. Morgan's No. 2 Rose Rogers, northeast of No. 1 and half a mile from production, is drilling at 2,440 feet; No. 1 S. J. Ryals, in center of field, is drilling at 1,220 feet.

Somerset Field—Bexar and Atascosa

Associated Petroleum Co.'s No. 3 Kohler, Rodriquez Survey No. 49 located 300 feet west of No. 2, has been put on the pump and is making 9 bbls. per day. N. A. Saigh's No. 3 Frees, Sam McCullough headright, 400 feet east of No. 2 has been completed and put on the pump and is making 18 bbls. per day. Grayburg Oil Co.'s No. 16 Shaw Survey 278, is location 225 feet to west line and 1,420 feet to south line; No. 29 Caruthers, Survey 377, located 1,000 feet east of No. 26, is drilling; No. 36 Ernest, Survey 366, is located 230 feet to east line and 716 feet to south line. Associated Petroleum Co.'s No. 16 Caruthers, William Caruthers, Survey is location 604 feet south of No. 2; No. 2 Ernest, Survey 266, is location 550 feet west of No. 1.

White Point Gas Field—Nueces

W. L. Pearson's No. 2 Meaney, located 300 feet from south line of tract, has derrick up and is waiting on rig; No. 2 Weil, located west of Corpus Christi, is swabbing at 2,360 feet.

LA.-ARK. WILDCATS

(Continued from Page 57)

tion 21-16-5, the hole being down 80 feet. Kimbrough and associates are drilling at 1,565 feet in No. 1 Cargle, Section 27-15-8, having resumed drilling a week ago after being shut down since March. Tunica Petroleum Co. is drilling at 850 feet in No. 30 L. & A., Section 34-16-7. Ten-inch surface casing was cemented at 50 feet.

Bossier Parish

Estes and associates are drilling at 2,735 feet in No. 1 Bodeau, Section 15-23-12. This is an old test being deepened. John Glassell, jr., and associates are arranging to abandon No. 1 Gibson-Tiger, Section 14-21-14. It was dry at 2,544 feet. Magnolia Petroleum Co. is arranging to drill the plug in No. 1 Dodson, Section 15-23-12. The plug is at a depth of 3,084 feet. W. R. Ramsey has cemented 8-inch casing at 2,845 feet in No. 1 Dodson, Section 16-23-12. Total depth is 3,077 feet. No. 1 Robertson, Section 22-23-12, is to be plugged back to the gas sand which was passed up in an attempt to find production deeper. This cored red shale at 3,392 feet. Sligo Syndicate is drilling at 3,350 feet in No. 1 Jeter, Section 23-17-12. Tubbs and associates are fishing for a drill stem in No. 1 Jacobs, Section 26-20-13, with total depth at 3,395 feet. Walker and associates are rigging up for No. 1 Antrim, Section 28-22-13.

Caldwell Parish

Grayson Oil Co.'s No. 1 Crockett, Section 6-12-4, has been shut down at 1,750 feet waiting orders.

Claiborne Parish

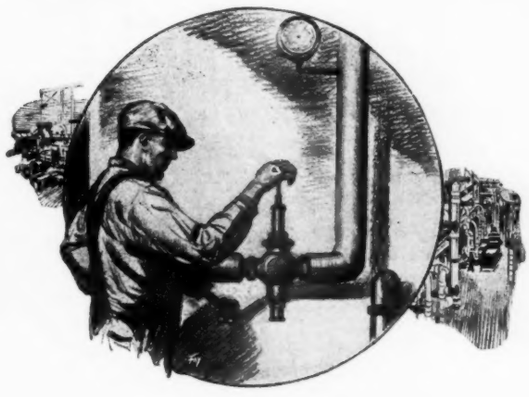
Mitchell & Jansen have abandoned No. 1 Wilburn, Section 23-19-7, having encountered a water sand at 3,105 feet. Magnolia Petroleum Co. is drilling red shale at 3,650 feet in No. 1 Lee, Section 16-22-8. Tate and associates are in a hard sandy shale at 2,350 feet in No. 1 Maddox, Section 21-23-7.

DeSoto Parish

Hoosier Oil Co. has cemented No. 1 Lanier, Section 5-11-11, flowing 250 bbls. daily. It has 15 feet of sand at a total depth of 2,700 feet. This company already has a rig up for No. 1 Perry in this section, and locations staked for Nos. 1 and 2 Lanier. Magnolia Petroleum Co. is coring lime and shale at 3,109 feet in No. 1 Logan, Section 17-10-12. Reliance Drilling Co. is coring at 1,984 feet in No. 1 Jones, Section 8-11-14. William Sebastian is plugging No. 1 Sebastian, Section 11-10-13, back to 3,929 feet after having reached a total depth of 3,405 feet. Seip and associates are drilling chalk rock at 1,972 feet in No. 1 Robertson, Section 18-10-12.

Grant Parish

Paulette and associates are down 840 feet in No. 2 Holmes, Section 17-9-1e, after having drilled out the 10-inch plug cemented at 100 feet. Rue and associates have finished cleaning out No. 1



"Once I set this pressure it'll stay set!"

This Mason Regulator is going to put that hand on the reduced pressure gauge just where I want it and next week, or next year for that matter, I can be sure it'll point to the same figure on the dial."

Mason Pressure Regulators for oil field service are designed, built and tested to meet rigid standards of accuracy and dependability. They are guaranteed by an organization that has specialized in pressure control engineering for forty-four years.

There is a Mason Regulator for every service in the field or refinery. For lasting dependability be sure to specify *Mason*.

Write for complete information.

Other Mason Regulators Include:

Liquid Level Controllers for maintaining the desired level in stills, absorber towers, receivers, etc.

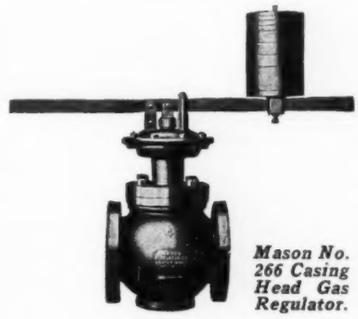
Gas Burner Regulators for gas pressures up to 250 pounds.

Reducing Valves for oil, gas, water, air.

Pump Speed Governors for controlling direct acting steam pumps or process work, booster lines, etc.

Balanced Valves. Rotary Shaft Type.

Pipe Line Strainers.



Mason No. 266 Casing Head Gas Regulator.

Mason Regulators

MASON REGULATOR CO.
Boston, Mass.

Muskogee, Oklahoma
Atlas Supply Company

Los Angeles, California
Warren & Bailey Company

Houston, Texas
J. A. Rossiter Company

516

Elias & Williams, Section 10-7-4w, but are shut down waiting orders. This test is down 1,913 feet. Swope and associates have a hole full of fluid in No. 2 fee, Section 18-9-1e, from sand at 1,596-98 feet. Tunica Petroleum Co. cored a salt water sand at 864 feet in No. 1 O'Bannon, Section 38-7-1e.

LaSalle Parish

Louisiana Oil & Refining Corp.'s No. B-1 Tremont, Section 30-10-2e, is shut down waiting orders at 1,582 feet. Tunica Petroleum Co. has 100 feet of oil in No. 29 L. & A., Section 9-7-2e, from sand at 768-75 feet. Six-inch casing has been cemented at 750 feet in No. 32 L. & A. This company also has a derrick up for No. 33 L. & A. No. 1 Whately, this section, which was abandoned temporarily several weeks ago, has 600 feet of fluid in the hole. Total depth is 830 feet.

Natchitoches Parish

Ohio Oil Co. is drilling at 2,395 feet in No. 1 Thomas, Section 23-13-6w.

Rapides Parish

George Sabatier and associates are down 1,310 feet in No. 1 Ritchie, Section 38-5-4, and are drilling ahead.

Red River Parish

Alden Oil Co.'s No. 1 Powell, Section 13-11-10, is in shale and boulders at 2,690 feet. Hazlett & Simmons are drilling at 500 feet in No. 1 Neeley, Section 1-14-12.

Richland Parish

Ruston Drilling Co. is drilling the plug in No. 1 Earle, Section 5-16-6e. This 6-inch plug is at 2,330 feet. Other Richland Parish operations are at a standstill.

Sabine Parish

Arkansas Fuel Oil Co. has completed No. 7 Logan, Section 33-10-12, flowing 315 bbls. daily from broken sand at 3,185-3,238 feet, and No. 2 Logan, Section 28-10-12, flowing 125 bbls. daily from sand at 3,195-3,226 feet. No. 6 Logan, Section 33, is drilling ahead in lime at 2,820 feet, and No. 8 Logan is in lime at a depth of 2,970 feet. No. 9 Logan, also this section, is drilling at 3,043 feet in shale. No. 1 Horn is in chalk rock at 1,745 feet. A derrick has been completed for No. 10 Logan, this section, and No. A-1 Logan, Section 23. The 6¾-inch casing has been cemented at 3,155 feet in No. 1 Moore, Section 32. Total depth is 3,170 feet. The casing is being bailed in No. 1 Rembert, Section 5-9-12. This test drilled out the plug cemented at 3,175 feet and is down 3,202 feet. No. 1 Williams, Section 33-10-12, is drilling in lime at 2,850 feet. L. M. Emlet has cemented 10-inch surface casing in the second hole being drilled at No. 7 Bowman. The hole is in excellent shape at a depth of 631 feet. No. 8 Bowman, Section 16-7-12, is shut down waiting orders at 579 feet. Louisiana Oil Refining Corp. is bailing No. 1 Logan, Section 28-10-12, for a test of broken sand at 3,197-44 feet. Magnolia Petroleum Co. is drilling at 2,365 feet in No. 1 Hall, Section 33. This company's No. 1 Louisiana L. L. L. Co., Section 2-6-11, is drilling sand and gumbo at 1,085 feet. Its No. 1 Rembert, Section 32-10-12, has started drilling and is down 100 feet. Morgan and associates also have started work in No. 1 Reese, Section 5-9-12, and after cementing surface casing at 100 feet are drilling ahead at 900 feet. C. W. Robinson and associates are drilling chalk rock at 1,975 feet in No. 1 Hamlin, Section 6-9-12. Woodley Petroleum Co.'s No. 1 Robinson, Section 33-10-12, is shut down for boiler repairs. The hole is at a depth of 3,315 feet.

West Carroll Parish

Phillips Petroleum Co. has staked a location for No. 1 Marion, Section 32-20-9e.

Winn Parish

Dodge & Cordell are drilling rock at 1,154 feet in No. 1 Tremont, Section 35-13-3w. Humble Oil & Refining Co. also is in rock at 743 feet in No. A-23 L. & A., Section 3-10-2w. H. L. Hunt is reaming to the bottom at 1,450 feet in No. 1 Tremont, Section 27-10-1w. Ohio Oil Co. tested dry at 2,556 feet in No. 1 McCarty, Section 5-12-1w, and now is coring at 2,560 feet. H. M. Roark has a rig up for No. 2 Southern Minerals Co., Section 19-11-3w.

ARKANSAS

Union County

C. H. Allison is drilling at 1,130 feet in No. 1 Howard, Section 8-19-13. Garrett Modisette Drilling Co. has abandoned No. 1 Union Saw Mill Co., Section 7-18-13. It had reached a depth of 4,309 feet. Marine Oil Co.'s No. 1 Winn Estate, Section 11-18-13, has tested salt water in sand at 2,706-11 feet. Ohio Oil Co. has cemented 4¾-inch casing at 3,009 feet in No. 1 Crain, Section 1-17-14. This well is closed in but showing oil and gas around connections. Total depth is 3,014 feet. Rovenger Oil Corp.'s No. 1 McCain, Section 4-17-14, has been completed pumping 40 bbls., 75 per cent salt water, from a sand at 2,834 feet. Sun Oil Co. is arranging to test at 2,643-57 feet in No. 1 Thompson, Section 10-18-13. Six-inch casing was cemented at 2,643 feet. Vaughn and associates' No. 1 Ezzell, Section 12-17-15, has 1,500 feet of oil in the hole at a total depth of 2,153 feet where it has 4 feet of sand, and is waiting on a standard rig.

Ouachita County

Magnolia Petroleum Co. is drilling at 800 feet in No. B-1 Stout, Section 28-14-16. The 13⅜-inch surface casing was set at 758 feet. Humble Oil & Refining Co. is drilling at 1,375 feet in No. 1 Jenkins, Section 15-14-19.

Calhoun County

Arkansas Natural Gas Co.'s No. 1 Stout, Section 2-13-14, has been shut down waiting orders with the hole at a depth of 1,850 feet.

Columbia County

Atlantic Oil Producing Co. is coring at 2,715 feet in No. 1 Couch, Section 23-17-20. It cored a sandy shale from 2,701 to 2,711 feet. Golquitt & Thomas' No. 1 Duffer, Section 23-18-19, has been shut down for fuel at 2,605 feet. Mitchell & Eylers' No. 2 Bodcau, Section 4-20-21, is drilling gummy shale at 2,501 feet.

Hempstead County

Arkansas Natural Gas Co. is drilling at 1,736 feet in No. 1 Goodlet, Section 34-10-26.

Little River County

Greason and associates' No. 1 Waldrop, Section 4-13-31, has been abandoned as dry at 1,740 feet. Mellick Oil Co.'s No. 1 Hawkins, Section 10-11-31, also has been abandoned at 1,593 feet.

Miller County

W. D. Nash and associates have abandoned No. 1 Priest, Section 26-14-27. It had reached a total depth of 3,850 feet. Lentz and associates' No. 2 Dale, Section 28-15-16, is in shale at 3,150 feet.

FARMINGTON, N. MEX.

(Continued from Page 61)

its well that first proved the existence of oil in the Farmington sands in the Blanco district.

Mancos River Structure

The Burke-Taylor well on the Mancos River structure, 19 miles north of Shiprock on Indian unsurveyed lands, is holding the interest of oil scouts, and the opinion is general that it has proved a new producer, but to what extent the production area extends and how productive the sands may prove remains to be demonstrated by further drilling. The showing is such that this will no doubt soon be made.

The Huerfano Oil Co., operating in the Bloomfield district, south of the San Juan River, Section 25-29-11, got a good showing of oil and gas at 115 feet the first of the week and was drilling at a depth of 120 feet at the last report.

The Mid-Continent Oil Co., operating on the Ransom tract in the Bloomfield district, Section 22-29-11, is about half way down to the producing sand and was drilling in shale at the last report at a depth around 500 feet.

Wiley & Craft, drilling on the Sheetz tract in the Bloomfield district under contract with R. M. Smith, expects to complete the well by the end of the week.

The Continental Oil Co., which is to have charge of the drilling when it is resumed on the Boundary Butte structure, 90 miles northwest of Farmington, is making repairs at the camp. In the nearly three years that have elapsed since drilling was stopped by order of the Federal Government, the machinery has deteriorated a good deal although a watchman was kept in charge.

The new tests are planned to be started in the vicinity of Farmington, one north and the other south of town, at an early date it is reported. The one that will be drilled in the vicinity of the old reservoir is said to be moving in the rig this week.

MAGNOLIA LINE HAS MANY NEW FEATURES

(Continued from Page 326)

line. He is in communication with other stations and terminals through the telegraph and telephone systems on both lines. The importance of the charts, which reflect the work of a skilled mathematician, is shown in the fact that a break in the line can be located within one-half a mile of the actual line leak a short while after the gauges give warning of line trouble. To do this, however, requires knowledge of the fundamentals of the charts worked out for the line.

The Sarepta-Beaumont line offers the Magnolia Petroleum Co. a rare economic condition for one of its oil lines and a condition without parallel. The Magnolia Pipe Line Co. has an 8-inch continuously welded oil line from the Smackover Field in Arkansas to the Magnolia company's Beaumont refinery. From Sarepta south all of the oil pump stations are powered by gas engines fueled by the gas from the gas trunk line.

CANADIAN FIELDS

(Continued from Page 62)

tana boundary. The Devenish test was financed by United Oils, Ltd., which holds approximtely 50 per cent of the Devenish Petroleums stock. United Oils, Ltd., was one of the companies organized in the Calgary boom of 1914, and after drilling an unsuccessful test in the Calgary area, it in 1915 drilled in the Sweetgrass Field of southern Alberta, ultimately developing a big gasser on the edge of what is now the Foremost gas field.

The Devenish strike has revived interest in the old Dreamfield Oil Co. well, put down some years ago in the same general area. T. J. Jamieson of Medicine Hat dreamed that he was shown a spot where oil would be found. On this nocturnal "hunch" Mr. Jamieson organized the company, putting down a test which was abandoned before it reached a conclusive depth.

Turner Valley

In the Turner Valley Field, southwest of Calgary, Royalite Oil Co. No. 4, LSD 12, Section 7-20-2w5, in April produced 18,668 bbls. of 73 gravity crude naphtha, an average of 622 bbls. a day compared with a total of 19,868 bbls. and a daily average of 641 bbls. in March. The wet gas flow shows no diminution, and the production decline is apparently what normally occurs with the return of warmer weather, the production reaching a peak in the winter months. For the past seven months the production in barrels was: October, 15,365; November, 15,563; December, 18,447; January, 18,846; February, 17,829; March, 19,838; April, 18,668.

Illinois-Alberta Oil & Refining Co. No. 1, LSD 14, Section 12-20-3w5, for May produced 2,644 bbls. of crude naphtha, averaging 85 bb's. a day, with a marked increase toward the end of the month. The production is sold to Imperial Oil, Ltd., at $3.95 per barrel at the well. Illinois-Alberta No. 2, same LSD, is reported starting work on derrick.

Vulcan Oils No. 1, LSD 11, Section 13-20-3w5, after being frozen a week, has blown in again and is making 115 to 140 bbls. a day, the production showing a slight increase over the previous output. Vulcan No. 2, same LSD, is reported drilling at 700 feet. Spooner Oils No. 1 LSD 12, Section 13-20-3w5, has fished out the lost bailer and is again drilling at 3,440 feet.

McLeod Oil Co. No. 2, LSD 16, Section 1-20-3w5, after drilling to 4,360 feet, has been put on the separator, and is reported making over 50 bbls. a day crude naphtha. McLeod No. 3, same LSD, is at 2,100 feet and drilling.

New McDougall-Segur No. 1, LSD 14, Section 12-20-3w5, in May produced 1,900 bbls. of 55-degree crude, according to sale and storage figures. New McDougall-Segur No. 2, same LSD, is at 120 feet and cementing the 20-inch to shut off surface water.

The latest production summary for the Turner Valley Field shows the following figures of estimated daily production: Illinois-Alberta No. 1, 87 bbls. naphtha; McLeod No. 2, 50 bbls. naphtha; McDougall-Segur, 70 bbls. oil; Royalite No. 4, 622 bbls. naphtha; Vulcan No. 1, 115 bbls. naphtha; total, 944 bbls.

Royalite Oil Co. No. 7, LSD 3, Section 13-20-3w5, rotary test, is at 3,157 feet and drilling. Dalhousie Oil Co. No. 1, LSD 4, Section 18-20-2w5, is finishing drilling through the cement at the bottom of the casing and will resume drilling at 3,680 feet. Dalhousie No. 5, LSD 16, Section 30-19-2w5, is drilling at 4,125 feet. Dalhousie No. 6, LSD 10, Section 13-20-3w5, is at 3,500 feet and drilling.

Great West Oils No. 1, SE Section 7-20-2w5, is at 5,370 feet and waiting for a milling tool to complete a difficult fishing job.

Okalta Oils No. 1, LSD 1, Section 1-20-3w5, is running special casing preparatory to resuming drilling at 2,400 feet. Regent Oil Co., LSD 16, Section 1-20-3w5, has resumed drilling at 2,100 feet, encountering a considerable flow of wet gas. The test is a considerable distance in the Dakota sand.

Cleared the Hole

Stockmen Oils, No. 1 LSD 1-2, Section 27-20-3w5, has cleared the hole of a lost bailer and is reported drilling at 4,150 feet. A number of lime bands have been penetrated, indicating that the top of the Madison is close. The drillers expect to underream and carry the 8¼-inch casing down to the Madison. Calmont Oils, LSD 2, Section 1-20-3w5, is at 3,730 feet and drilling, with the 10-inch casing some 500 feet from bottom and the open hole standing up well. J. C. Dallas, president and managing director of the Calmont Oils, has left for England to interest British capital in the development. Sentinenl Oils, Section 8-20-2w5, is drilling at 1,350 feet, with the 15½-inch casing down to 1,200 feet.

Shareholders of Ellis Oils, Ltd., have approved the sale of the company's 20-acre lease in the Turner Valley field to Spooner Oils, Ltd., in exchange for 63,660 shares of Spooner stock. Ellis Oils, Ltd., may secure other acreage for development. The directors of the company are: President, Robert Wilkinson; vice president, A. G. Spooner; secretary, D. Duncan; directors, G. E. McGinnis, G. B. Snyder, L. A. Newman, R. A. Wilderman.

At the annual meeting of Dolomite Oils, Ltd., at Calgary recently, the following directors were re-elected: President R. W. Ward; vice president, T. W. McGuckie; directors, F. L. Shouldice, S. A. Hall, F. E. Spooner; secretary, S. G. Baggs. The Dolomite test, LSD 8, Section 1-20-3w5, is shut down at 1,300 feet with 15½-inch casing set at 1,005 feet.

Anaconda Oil Co., Ltd., has arranged to purchase the entire assets of the Titan Oil Co., Ltd., which include 1,540 acres in the Turner Valley and other fields. Titan Oils Co. shareholders will receive stock in the Anaconda company. The Titan made a location last season in LSD 2, Section 18-20-2w5, but no work has been done. The Anaconda, as soon as the deal has been ratified, will commence the erection of camp and derrick in NE LSD 13, Section 20-19-2w5. A Chicago syndicate has undertaken to drill a well on this location for a block of Anaconda stock and certain royalties; and the drilling contract has been let to Robert C. Heslop, who will move in a heavy standard rig and tools from Salt Creek, Wyo.

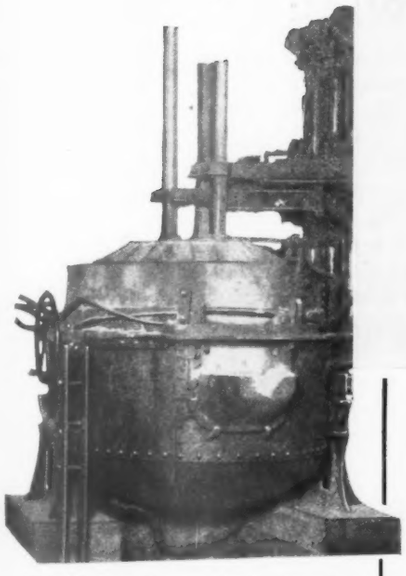
Toronto brokers, understood to be acting for the newly-organized Imperial Oil, Ltd., subsidiary, the Foothills Oil & Gas Co., have purchased acreage in the Turner Valley from Patrick Treanor and Owen Bryant. The Treanor holdings comprised 280 acres in the E half of Section 34-20-3w5, and the Bryant holdings were LSD 11, same section. In the deal, Treanor transferred also the controlling

SIVYER (S) CASTINGS

DEPENDABLE

Sivyer Alloy Electric Steel Castings can be Forged, Welded and Tempered.

This is the old fashioned, inaccurate way alloys can be made —"doping the pot" with alloying elements. Sivyer does not dope the pot.



This ½-Ton Furnace Ends "Doping the Pot" on All Alloy Runs

The old fashioned method for making alloy castings is to "dope the pot."

The alloying elements are dumped into the pouring pot which is then filled with steel from a general heat. If the practice is thorough the mixture is stirred with a rod before it is poured into the mold. By this haphazard method there is no assurance that the added elements will be absorbed by the metal and variations from uniformity in even the same pot are common.

Sivyer maintains a ½-ton electric furnace to melt those alloy jobs which do not require all the metal of a large furnace heat.

Control is close always. Absorption of all elements is assured and distribution is uniform for all are melted together. Heats are consistent. And the service you get from one casting is indicative of the service you will get from any subsequent casting in the same alloy. *Ask us to prove this point.*

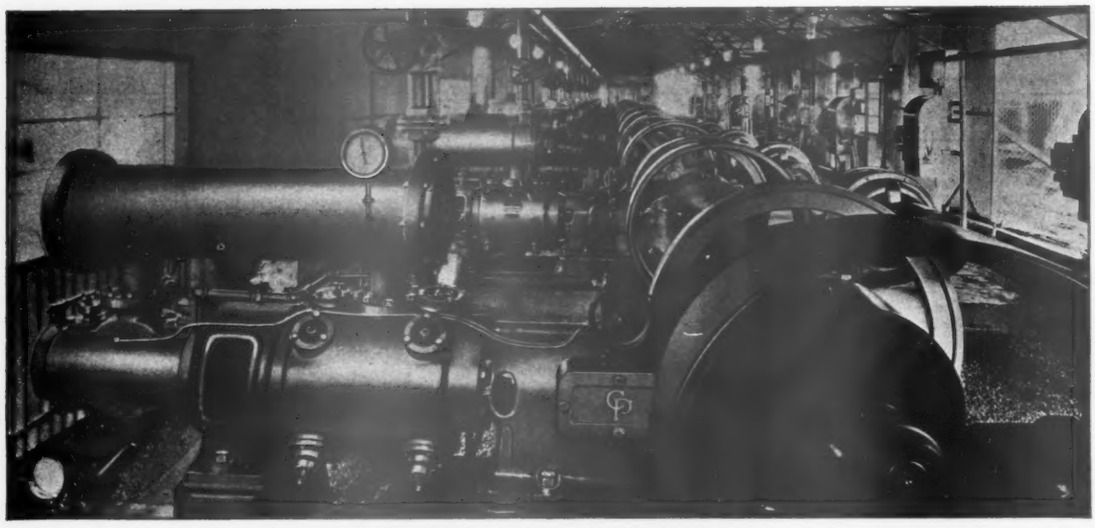
MID-CONTINENT OFFICE
1415 F. & M. Bank Bldg., Ft. Worth, Texas

How Alloy Castings are Made Determines How They Serve

The making of alloy steel castings is a highly technical job. Elements must be closely proportioned and closely controlled to assure the uniformity that spells consistent service. Ordinary foundries can make metals that approach given alloys by "doping the pot"—(dumping the required alloying elements into the pouring pot before it is filled with steel from the general heat). But only a foundry geared by experience to the making of alloys—as the Sivyer Foundry has been for 15 years—can assure that every casting will match its formula. Sivyer makes its alloys in a furnace where they are closely controlled—not in the pouring pot. The difference can be best measured by the added service in the field.

SIVYER STEEL

SIVYER STEEL CASTING COMPANY, MILWAUKEE



12 CP Tandem High-Pressure Compressors, belted to electric motors for artificially flowing wells in Seminole Field.

CP Compressors for Artificially Flowing Wells

Oil-Field Equipment:

Compressors for flowing wells.
Vacuum Pumps, Condensers and Compressors for refinery service.
Gas compressors for pressure boosting.
Diesel Engines 80 to 450 h.p.
Gas Engines 90 to 540 h.p.
Portable Oil and Gasoline Engine-powered Air Compressors for cleaning wells and tank farm work.
Pneumatic Riveters, Chippers, Caulkers, Scalers, Drills, Reamers and Grinders to handle every job requiring portable tools.

WHEN some 325 CP Air Compressors, Oil and Gas Engines are installed by more than 100 mines within a radius of 50 miles, such as the Tri-State Mining Region, commonly known as the "Joplin District," they've got to be good and backed by a dependable service.

It is not surprising, then, that CP equipment has proved equally successful in the near-by oil fields of Oklahoma. The sterling performance required by the Tri-State Mines is equally essential in the flowing of oil wells—with operating conditions fluctuating widely but always severe. The number of CP Compressors used in this service equals that of all other makes combined. This isn't accidental; there are sound reasons for it.

If you have oil wells to flow, tanks to erect, pipe lines to lay, refineries or extraction plants to equip, let our oil-field engineers confer with you—they have had a wide experience in all branches of the industry.

Chicago Pneumatic Tool Company

6 East 44th Street, NEW YORK, N. Y.

Whealton & Townsend, Inc., *Authorized Distributors*

Higgins Bldg., Los Angeles — 120 East Brady St., Tulsa — 210 So. Jefferson St., Dallas — 1415 Fannin St., Houston

*Sales and *Service Branches all over the World*

*Birmingham	*Cleveland	Houston	*New York	*San Francisco	*Berlin	Calcutta	Helsingfors	*London	Moncton	*Paris	*Sao Paulo	Timmins
*Boston	Dallas	Knoxville	*Philadelphia	*Seattle	Bogota	Copenhagen	Honolulu	Madrid	*Montevideo	Ponce	Seoul	Tokyo
Buffalo	Denver	*Los Angeles	*Pittsburgh	*St. Louis	*Bombay	Dairen	*Johannesburg	Manila	*Montreal	Rio de Janeiro	Stockholm	*Toronto
*Chicago	*Detroit	*Minneapolis	Richmond	Tulsa	*Brussels	*Durban	Kobe	*Mexico City	Osaka	*Rotterdam	Sydney	*Vancouver
*Cincinnati	El Paso	*New Orleans	Salt Lake City	Athens	*Buenos Aires	*Havana	Lima	*Milan	Oslo	Santiago	Tampico	*Winnipeg

Canadian Pneumatic Tool Company, Ltd., Montreal, manufacturers of Chicago Pneumatic products in Canada
Consolidated Pneumatic Tool Company, Ltd., London, manufacturers of Chicago Pneumatic products in England

C 258

CHICAGO PNEUMATIC AIR COMPRESSORS · BOYER PNEUMATIC HAMMERS · ROCK AND COAL DRILLS · CONDENSERS
LITTLE GIANT PNEUMATIC AND ELECTRIC TOOLS · GIANT OIL AND GAS ENGINES · VACUUM PUMPS · OIL BURNERS
PAINT SPRAYERS · TOOL BALANCERS — PNEUMATIC HOISTS · SAND BLASTERS

CHICAGO *Depend upon* **PNEUMATIC** *that Name*

interest in Seneca Oils, Ltd., and the 40 acres on which the Madison Oils, Ltd., has a location, the purchasers taking over the contract with Madison Oils. The acreage is just north of the site on which Imperial-Millarville No. 1 is rigging up in SW Section 26-20-3w5. It is reported that Imperial-Millarville No. 1 will be taken over by the Foothills Oil & Gas Co., and that the Seneca Oils test, LSD 1, Section 34-20-3w5, shut down at 2,706 feet, will also be completed by the Foothills company. The Madison lease was contingent on the company starting drilling by July 1, 1927. The Foothills Oil & Gas Co. now has approximately 2,000 acres in the Turner Valley Field. A recent issue of 100,000 shares of Foothills stock, oversubscribed on the Toronto market at $2.50, apparently was the consideration for the Treanor and Bryant deals.

The Provincial Department of Public Works has commenced work with a grader and crew on the roads into Turner Valley, the roads between Black Diamond and the Imperial Millarville well receiving first attention. The main road through the valley is in bad condition, a caterpillar outfit moving a boiler to the Imperial-Millarville site getting stuck recently.

Southern Foothills

In the southern foothills, the Imperial Oil, Ltd., Highwood No. 1, LSD 3, Section 36-18-3w5, is underreaming at 2,400 feet with casing at 2,380 feet.

On the Morley Indian Reserve, Gold Coin Oils is drilling at 2,525 feet in a hard cap rock, with a small gas flow. A diamond drill outfit is being used.

In the Gleichen area, Oil Producers Corp. of Canada is making a location for a test and expects to spud in about July 1.

In the Irma-Wainwright Field, Mid-Canada Oil Co. has rig timbers at Wainwright and will probably drill in Section 35-45-6w4, in the Baxter Lake area. National Exploration Co., LSD 1, Section 30-45-6w4, which has been shut down waiting for casing, has resumed and is cementing the surface casing. The hole is down about 360 feet. Surface casing is also being cemented at the British Wainwright No. 1, LSD 4, Section 22-45-6w4. Frank E. Stevens and Harry Elliott are in charge of this test.

On the Montana Side

On the Montana side of the international boundary, it is reported that the S. Hart Green-Lerum No. 1, SW Section 11-37-2w, will be abandoned and a new test drilled in the immediate vicinity. Abandonment is owing to water and caving troubles, the condition of the hole, and the small size of the casing. The bit entered the Eillis sand at 2,335 feet and oil rose several hundred feet in the hole. The strike was followed by the caving of about 200 feet of open hole and the intrusion of considerable fresh water. Prior to this a potential production of 100 to 250 bbls. a day was indicated. The well is 2 miles south of the Alberta boundary, and 8 miles southeast of Coutts. While the producing sand is generally reported to be the Ellis, it does not entirely check up with that sand, and H. M. B. Inglis, geologist for the syndicate, thinks it may be a stray sand above the Ellis. Samples of the oil show a dark brown product testing 22 degrees. In drilling, the casing was rapidly reduced, with the 3 5/16-inch string 200 feet above the pay. In drilling the new test it is planned to land the 8¼-inch casing on top of the sand. The S. Hart Green Syndicate was financed by a group of Winnipeg men headed by T. B. Kyle. It is reported that a Vancouver syndicate has offered to drill on the S. Hart Green acreage and will likely put down a test in Township 2-15w4 on the Alberta side, where the structure is broader. An American outfit will also drill a test in Township 1-14w4, just north of the border.

On the Quarantine Reserve near Coutts Urban Oils, Section 4-1-15w4, is pulling casing and abandoning the test, which failed to develop commercial production after being drilled to 3,420 feet. In the Cypress Hills district, a Toronto syndicate which recently blanketed extensive acreage has shipped a rig to Manyberries for a test.

Commonwealth Oils, Ltd., which has been core drilling in Section 17-3-15w4, is getting ready to spud in its commercial test. Eugene Coste will make the location. H. M. B. Inglis will be field superintendent for the Commonwealth. It is reported that the Canadian Western Natural Gas Co. will locate a test this month in the Milk River area, on what is claimed to be the northward extension of the main axis of the Sweetgrass arch.

In Saskatchewan, the Equitable Oil Co. of Regina has been incorporated under Dominion charter with $5,000,000 capitalization. The company holds 1,000 acres of leases on the Saskatchewan end of the Ribstone-Blackfoot structure, 5,000 acres in Montana and 320 acres at Osage, Wyo. Drilling has commenced in Montana in the Kremlin district and the company expects to drill in the Ribstone and Osage areas this summer. Officers of the company are: President, Senator H. W. Laird, Regina; vice president, Hon. James R. Wilson, Saskatoon; secretary-treasurer, C. B. Keenleyside; directors, John Laycock, Saskatoon, and S. A. Hole, Shelby, Mont. The Oxville Oil & Gas Co. of Oxville, Sask., is getting ready to drill its test in Section 10-45-2w4, on the Alberta end of the Ribstone structure.

In the Grandview district of Manitoba the Irro Oil & Refining Co. has spudded in a test 50 feet from its No. 1 well.

In Ontario, Union Natural Gas Co. No. 15 in Dawn Township, Lambton County, is reported drilling at 1,500 feet. In Kent County Union Natural Gas Co. No. 267 on the George A. Jackson farm near Port Alma has finished a small gasser in the Tilbury farm. The campany has started No. 268 on the Jackson farm. In the Camden Township Pool, the E. P. Rowe interests and the Vacuum Gas & Oil Co. are reported to have two outfits at work in the shallow field.

OKLAHOMA FIELDS

(Continued from Page 52)

A. G. Oliphant's No. 1 NW cor. SW NE, Section 16-25-8, is drilling at 200 feet. Oklahoma Natural Gas Corp. has a machine out to drill No. 768 SE cor. NE SE, Section 38-22-11. Sand Springs Home made location for No. 104 NW cor. SW, Section 28-20-10.

Peters Petroleum Co.'s No. 7 NE cor. NW NW, Section 17-27-6 flowed 768 bbls. natural from the Burbank sand 2,945-3,000 feet and was shot with 120 quarts which increased the production to 850 bbls. Skelly Oil Co.'s No. 1 SE cor. SW, Section 12-26-4, had a hole full of water in the Wilcox sand 3,545-80 feet and is abandoned. George Parker's No. 4 NW cor. SW, Section 28-26-6, drilled the Burbank sand 2,942-90 feet and after a shot of 120 quarts made 151 bbls.

Pittsburg County

Quinton Spelter Co.'s No. 1 Featherstone, CWL NW, Section 22-7-17, is spudding.

Pontotoc County

Louisiana Oil Refining Co.'s No. 2 Harjo, SE cor. SW SE, Section 17-5-8, is rigging up rotary tools. No. 3 Harjo, SE cor. SW, Section 17-5-8, has the rig up. No. 1 Gilcrease, NE cor. NW NE, Section 20-5-8, is producing 240 bbls. from sand 2,442-50 feet.

Pottawatomie County

Roxana Petroleum Co. is building the rig for No. 1 Balus, NW cor. NE SW, Section 17-9-5. Sikes, Kilgore and Shaffer Oil & Refining Co.'s No. 1 Klein, C SE SE, Section 26-11-4, had a hole full of water in the Wilcox sand 5,560-77 feet and has been abandoned. Phillips Petroleum Co.'s No. 5 Gram, NE cor. SW SE, Section 9-9-5, has been completed for 750 bbls. in the Wilcox sand 4,339-45 feet. Gypsy Oil Co.'s No. 2 Earl, NW cor., Section 16-9-5, topped the Wilcox sand at 4,309 feet drilled to 4,310 feet where water was encountered. The well was bradenheaded and is producing 85 bbls. from the Earlsboro sand 3,860-80 feet. No. 2 Strain, NE cor. SE NE, Section 17-9-5, had water in the Wilcox sand 4,373-88 feet and is producing 22 bbls. from the Misner sand 4,095-97 feet.

Seminole County

The Texas Company is building the rig for No. 5 Wilmott, SE cor. NE SE, Section 10-9-5. Earlsboro Pool. Barnsdall Oil Co. has the cellar dug for No. 1-A. D. Davis, NW cor. SE, Section 11-9-5. Location was made for No. 2-A, M. Davis, NE cor. SW, Section 11-9-5. Gypsy Oil Co. made location for No. 4 Carter, NW cor. NE NW, Section 11-9-5 Magnolia Petroleum Co. made location for No. 7 Sparks, SW cor. NW SW, Section 11-9-5. Location was made for No. 1 Rogers, SW cor. SE NW, Section 11-8-6, Bowlegs Pool. Sinclair Oil & Gas Co. is building the rig for No. 7 Ellen, SE cor. NE SW, Section 11-8-6. Roxana Petroleum Corp. has the rig on the ground for No. 6 Taylor, NW cor. NE NE, Section 16-8-6. Magnolia Petroleum Co. made location for No. 6 Franz, NE cor. NW SW, Section 32-8-8, Wewoka Pool.

Barnsdall Oil Co.'s No. 1 Bruner, SW cor. SE SW, Section 2-9-5, swabbed 35 bbls. from the Earlsboro sand 3,493-3,521 feet. No. 1 Peter, SW cor. SE SW, Section 10-9-5, topped the Wilcox at 4,401 feet drilled to 4,403 feet and swabbed 333 bbls. Magnolia Petroleum Co.'s No. 4 Sparks, NW cor. SW SW, Section 11-9-5, has been deepened from 4,311 feet to 4,315½ feet and made 4,562 bbls. Sinclair Oil & Gas Co.'s No. 1 Grisso, SE cor NE NE, Section 22-9-6, Seminole Pool, had an initial production of 865 bbls. from the Hunton lime 4,168-96 feet. Empire Gas & Fuel Co.'s No. 1 Gross, NW cor. SE, Section 25-9-6, was shot with 20 quarts in the Wilcox sand 4,208-28 feet and swabbed 765 bbls. No. 2 Gross, SW cor. SE, Section 25-9-6, swabbed 650 bbls. after a shot of 10 quarts in the Wilcox sand 4,263-81 feet. Magnolia Petroleum Co.'s No. 4 Franks NE cor SW SW, Section 25-9-6, had the top of the Wilcox sand at 4,267 feet, drilled to 4,273 feet and produced 600 bbls. after a shot of 20 quarts. Barnsdall Oil Co.'s No. 1 Graull, SW cor SE SW, Section 10-9-7, is dry and abandoned at 3,658 feet. The Texas Company's No. 1 Butler, SE cor. NW, Section 7-9-8, had sand 3,302-16 feet, drilled on to 3,324 feet and swabbed 40 bbls. after a shot of 60 quarts. Atlantic Oil Producing Co.'s No. 3 Baker, SE cor., Section 10-8-6, Bowlegs Pool, 1,771 bbls. from the Wilcox sand 4,025-61 feet. Carter Oil Co.'s No. 2 Harjoche, NW cor., Section 14-8-6, was put on air and flowed 2,305 bbls. from the Wilcox sand 4,133-85 feet after it was shot with 60 quarts. Pure Oil Co.'s No. 13 Reed, SW cor. NW SE, Section 14-8-6, had the Wilcox sand 4,263-93 feet and produced 2,138 bbls. when the air was applied. The Prairie Oil & Gas Co.'s No. 1 Weimer "A," SE cor. NE NE, Section 22-10-6, Searight Pool, was completed for 200 bbls. in the Hunton lime 4,245-50 feet. The Texas Company's No. 1 Reed, SE cor. NE, Section 14-8-6, Bowlegs Pool, made 3,615 bbls. initially from the Wilcox sand 4,221-46 feet. Amerada Petroleum Corp.'s No. 2-A, Rascoe, NW cor. NE SW, Section 15-8-6, found the top of the Wilcox at 4,130 feet and had lime break from 4,192-4,230 feet, went in to sand again at 4,230 feet and drilled to 4,271 feet and when put on air produced 875 bbls. Indian Territory Illuminating Oil Co.'s No. 2-A, Goforth, SE cor. SW NE, Section 15-8-6, produced 820 bbls. when the air was applied the oil coming from the second break in the lime 4,362 feet. No. 10 Goforth, SW cor. NW NE, Section 15-8-6, flowed 4,121 bbls. by air, production coming from the second break in the lime 4,286-93 feet. No. 9 Livingston, NW cor., Section 15-8-6, was completed for 4,303 bbls. after a shot of 20 quarts in the Wilcox sand 4,458-68 feet. No. 10 Livingston, SE cor. NE NW, Section 15-8-6, topped the Wilcox sand at 3,953 feet had lime break from 4,005 feet to 4,043 feet, went into sand again at 4,043 feet and drilled to 4,052 feet, the initial production being 861 bbls. Atlantic Oil Producing Co.'s No. 1 Fleet, NE cor. NW, Section 23-8-6, made 4,008 bbls. after being shot with 15 quarts in the Wilcox sand 4,239-57 feet.

Stephens County

Beard & Cobb made location for No. 1 Leach, NE cor. SE NW, Section 11-2s-8w, Gilmer Oil Co.'s No. 3 Inscore, NW cor. SE SE, Section 24-1s-4w, came in for 1,200 bbls. from a series of sands 2,375-2,948 feet. Beard & Cobb's No. 1 Wade, SW cor NW NE, Section 11-2s-8w, is flowing 160 bbls. from sands 1,502-08

PARMACO
PARKERSBURG MACHINE CO. PARKERSBURG, W. VA. U.S.A.

For—

Packers

Stuffing Box Casing Heads

Casing Shoes

Write to

PARKERSBURG MACHINE CO.

PARKERSBURG, W. VA.

"The House of Courteous Service"

BURT

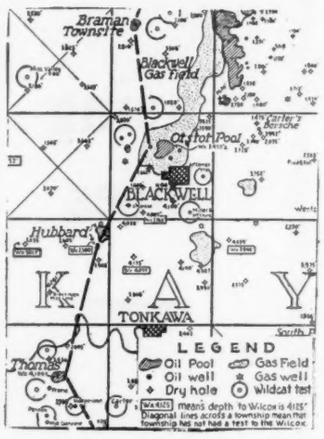
Oil Filtering Equipment

Ventilators
Exhaust Heads

For over 30 years BURT has designed and built quality products that have led the field. All BURT products are made of high grade materials manufactured to the BURT standard of careful workmanship and their performance is guaranteed.

Write for prices and specifications on the new Burt Direct Connected Fan Ventilator. It is just what you have been looking for in perfect ventilation.

THE BURT MANUFACTURING COMPANY
929 S. High St., Akron, Ohio
Pioneer Oil Filter Manufacturers



A small reproduction of part of a large map which appeared in a previous issue.

All Oil and Gas Journal maps, charts, well-logs and cross sections are dependable.

They are always up to date, prepared from first hand information gathered right on the spot in the oil fields, and appear at a time when *they are most valuable.*

Territories have been explored successfully by oil companies and individuals who were guided by the information contained in the Maps, Charts, Well-logs, and Cross Sections published exclusively in The Oil and Gas Journal—"The Oil Man's Bible."

Be among the best informed oil men. Read The Oil and Gas Journal. Get it at your home or office every week and always renew your subscription promptly.

The Oil and Gas Journal
Tulsa, Okla.

feet and 1,508-22 feet, the former being broken sand. Carter Oil Co.'s No. 1 Morris, NE cor. NW SE, Section 9-1s-5w, has been abandoned at 3,195 feet. Murphy Oil Co. has abandoned No. 3 Payne, NW cor. SW SW SE, Section 2-1-5w, the depth being 2,002 feet.

Waggoner County

O. A. Sewell and others moved a machine out for No. 1-A Sweet, CSL NE SE, Section 11-16-15. C. M. Bradley has a machine at the location for No. 1 Tallahassee Mission, NE cor. SW NE, Section 20-16-8.

O. A. Sewell's No. 1 Charles, NW cor. SE SE, Section 28-17-16 was shot with 40 quarts and made 4 bbls. in sand 1,024-32 feet.

Lone Star Co. Buys Distributing System Of The Texas Company

FORT WORTH, Tex., June 13.—The natural gas distributing system of The Texas Company in its North Central Texas division has been sold to the Lone Star Gas Co. of Dallas, Tex., effective June 1, 1927, and the latter concern will take over operation of the lines and active management at 7 a. m. June 14. The deal was consummated by L. E. Barrows, division manager, with offices at Fort Worth, and involves a sum of money running well into seven figures, although the actual consideration has not been made public.

Sale of this equipment and property is a big step in the expansion program of the Lone Star Gas Co. in West Texas and takes The Texas Company out of the gas distributing business in that area, a phase of the industry in which the company started as far back as 1909. This was at Moran in Shackelford County. Later, the company's lines were extended to Albany, Clyde, Cisco, Baird, Putnam, Eastland, Sedwick and Crystal Falls. All gas contracts for purchase and sale as well as the 250 miles of pipe lines and three compressor stations are included in the transaction.

By this deal the Lone Star Gas Co. acquires more than 10,000 new consumers and is planning to extend its newly acquired system still further. A franchise has been acquired at Sweetwater and the lines may be extended on to Colorado City and also north of Sweetwater.

The West Texas Utilities Co. has handled the distribution of gas for The Texas Company in Abilene and Cisco, the Albany Natural Gas Co. in the town of that name and the Eastland Gas & Electric Co. at Eastland. These will continue to operate without change. In the other towns affected by the deal, the distribution will be handled by the Community Natural Gas Co., subsidiary of the Lone Star Gas Corp.

The Lone Star has a large reserve gas supply in that part of Texas, particularly in the Ibex Field of Shackelford County, and its new lines are close to the 25,000,000-foot gas well drilled in this week by the Transcontinental Oil Co. on the Weddington tract northwest of Cisco in Eastland County.

It is said that nothing is known of any contemplated purchase of the Lone Star Gas Co. by the Phillips Petroleum Co.

OSAGE OIL EXEMPTION

The United States Supreme Court has granted the internal revenue collector for the twenty-third district of Pennsylvania, a review of the Third Circuit Appellate Court's decision exempting from taxation income derived from the sale of oil extracted from the Osage Indian Tribal Lands by non-Indian operating lessees. The Internal Revenue Bureau has held that such income was taxable and the Treasury will have to refund $150,000,000 to oil companies if lower courts are sustained when the case is heard on its merits. The question involved is whether Congress intended to exempt income of tribal lands, derived from operation under lease.

D. R. Weller Returns As President of the Louisiana Standard

SHREVEPORT, La., June 11.—Succeeding the late C. K. Clarke, who died last March, D. R. Weller was elected president of the Standard Oil Co. of Louisiana at a meeting of directors in the company's offices at Baton Rouge the past week. Mr. Weller is a member of the board of the Standard Oil Co. of New Jersey and for many years was president of the Louisiana company.

The directors also elected W. L. Stratton, vice president and in charge of the

D. R. WELLER

Shreveport offices of the company, to membership on the board. He succeeds the late J. T. Massey, of Memphis, whose office has been vacant for more than a year.

All other officers and directors were re-elected, including A. K. Gordon, vice president and treasurer; C. O. Scholder of New Orleans, vice president; C. I. Fiero, of Baton Rouge, vice president; J. A. Bechtold, vice president and secretary; and C. O. Scholder of New Orleans, C. I. Fiero of Baton Rouge, Mr. Stratton, T. H. Taylor of New Orleans, L. Link of Baton Rouge, W. C. Megarity of Shreveport and J. V. Gresham, vice presidents.

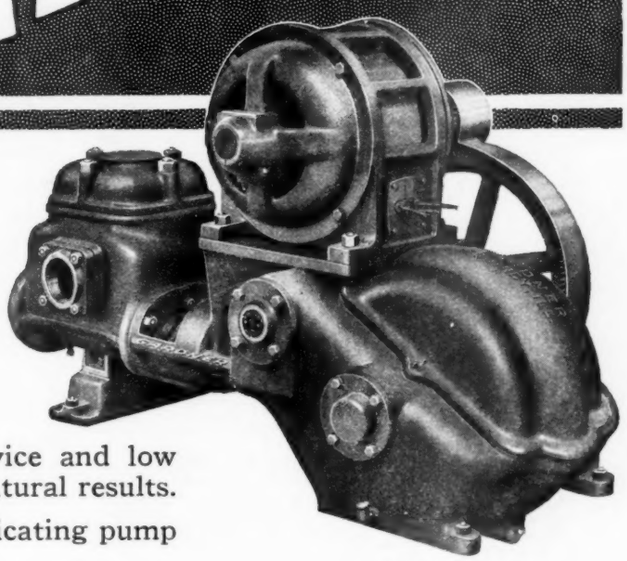
Mr. Weller went to Baton Rouge in 1909 to assist in the construction of the refinery of the Standard Oil Co. of Louisiana and became president of the company December 31, 1919. He resigned on February 15, 1926, to go to New York and was succeeded by Mr. Clarke.

HOUSTON GAS RATES IN FURTHER TANGLE

HOUSTON, Tex., June 11.—The City Council has rescinded the rate increase granted the Houston Gas Fuel Co. and granted the Houston Natural Gas Co. now supplying 10 suburbs with natural gas, a franchise to operate in other outlying industrial districts within the city boundaries. The council has advised the Houston Gas Fuel to reduce the rate it pays Houston Gulf Gas Co. for natural gas, sufficient to enable it to operate under the old rates, which Houston Natural Gas Co. has offered to operate under. However, this would conflict with the terms under which Houston Gulf Gas recently sold a bond issue.

Following the reduction of Houston gas and fuel rates to former basis, the City Council states the question of giving Houston Natural Gas Co. a franchise will be submitted to voters as soon as E. H. Buckner, president of the company, submits draft to desired franchise.

Automatic Lubrication!



All working parts of Gardner Power Pumps are constantly operating in a flood of oil. Pumps require oiling *once* a month in *one* place.

Long life, trouble-free service and low maintenance cost are the natural results.

There is a Gardner self-lubricating pump for every requirement.

Send for Bulletin EP-3.

Packed Piston Type Direct Connected to Motor

"Quality Builders for Over 65 Years"

THE GARDNER GOVERNOR CO.
Quincy, Ill.

CHICAGO 549 Washington Blvd.	NEW YORK 534 Singer Bldg.	PHILADELPHIA 604 Arch St.	MUSKOGEE 323 Dayton St.
HOUSTON 611 2nd Nat'l Bank Bldg.	SAN FRANCISCO 401 Rialto Bldg.	LOS ANGELES 684 Santa Fe Ave.	LONDON 25 Bishopsgate E. C. 2

OIL COUNTRY DISTRIBUTORS

Alamo Iron Works, San Antonio, Texas.
Atlas Supply Company, Muskogee, Tulsa and Fort Worth.
Kirk W. Eichelberger, 401 Rialto Bldg., San Francisco.
Emsco Derrick & Equipment Co., 6811 So. Alameda St., Los Angeles, Calif.
Haywood-Williamson, Shreveport and El Dorado.
F. W. Heitmann Company, Houston.
International Supply Co., Stores in all principal Mid-Continent fields.
Norvell-Wilder Hdwe. Company, Beaumont, Houston and Fort Worth.
The Republic Supply Co. of California, Stores in all principal California Oil Fields.

GARDNER GOVERNORS PUMPS · COMPRESSORS

GARDNER

35 CENTS a line first insertion; 25c a line each additional insertion. Cash in advance.

CLASSIFIED WANTS

CREATE AND BUILD BUSINESS

MAIL your advertisement now. It will be published next week. Cash with order.

FOR SALE—EQUIPMENT

FOR SALE—Drilling machine No. 20 Leidecker Complete bought new 1 year ago; will sell at bargain. J. A. Ronshausen. Athens, Ohio.

DIESEL
GENERATOR
UNITS
Like New

3—625 kva., Allis-Chalmers Generators, 3 phase, 60 cycle, 2,300 volts, 180 r.p.m., direct connected to 750 hp, Busch-Sulzer-Diesels, with direct connected exciters. Units are modern, have seen hardly any service, practically good as new. Can be demonstrated operating. Complete details and photo on request.
EQUITABLE EQUIPMENT CO., INC.
410 Camp St., New Orleans, La....

FOR SALE CHEAP
Gasoline compression plant located Central Ohio. Good conditions, slightly used. Capacity 350,000 ft. Will load on board cars for $2,500. J. H. Harmon, 14 Massa Ave., Mansfield, Ohio.

FOR SALE—Two stage pump direct connected to 15 H. P. 220 V. 3 phase G. E. slip ring 1200 RPM A. C. motor. Also lot of gas engines from 5 to 20 H. P. Like new at bargain. Queen City Electric Co., 1732 Grand Ave., Chicago, Ill.

FOR SALE—EQUIPMENT
5 Dean Triplex Pumps, 5 by 8.
1 No. 2, 1 No. 5, 1 No. 6, 1 No. 7, 1 No. 10, 1 No. 11 Sweetland Oil Filters.
Two 10-inch S. Roturbo Centrifugal Pumps. Six 10-inch S. Centrifugal Pumps. Steam Turbine.
Storage Tanks. Send for list.
Send us your inquiries. We buy your surplus equipment.
CONSOLIDATED PRODUCTS CO.
15 Park Row, N. Y. C. Barclay 0603.

HOWELL 3-in-1 VALVES
On your lease tanks insure positive safety, automatic operation, low cost and the greatest possible saving of vapors.
HOWELL VALVE WORKS
Kansas City

EFFICIENT help can best be obtained if you go after your man by using The Oil and Gas Journal Classified Ads.

FOR SALE CHEAP — Gasoline compression plant, good condition, located Central Ohio. Capacity about 350,000 feet. Price $2,500. J. Harmon, 14 Massa Ave., Mansfield, Ohio.

USED LINE PIPE AND CASING FOR SALE
7—25-h. p. used gas engines.
10—6-in. standard rigs.

15,000 ft. 5½-in. used casing.
15,000 ft. 6⅝-in. used casing.
10,000 ft. 8¼-in. used casing.
5,000 ft. 10-in. used casing.

75,000 ft. 3-in. used line pipe.
50,000 ft. 4-in. used line pipe.
20,000 ft. 6-in. used line pipe.
For immediate shipment from our Texas yards.
KEYSTONE PIPE & SUPPLY CO.
607 Holmes Bldg.,
Fort Worth, Tex.

STANDARD RIG FOR SALE
New 120-foot standard rig, complete; has just drilled one well; good 6-inch Marion rig irons; set Marion iron bull wheels; set Lucy calf wheels; 65 H. P. Lucy boiler; new style Ajax engine complete; O. W. S. engine; two 250-bbl. steel tanks; underreamers; elevators, gas burners; belts; casing line; crown block; casing clamps and considerable other drilling equipment; all in first-class condition; practically as good as new and offered at a great discount. Write R. S. Renderson or H. L. Berry, 318 Braniff Building, Oklahoma City, Okla. Telephone Maple 0778.

TANK TABLES

TANK TABLES—Machine Made Accurately computed, lowest price. Mid-Continent Tank Auditing Co. 108 Tuloma Bldg., Tulsa, Phone 4-1410 O. R. TISDALE, B. S., C. E.

EQUIPMENT WANTED

WANT TO BUY
Ten miles used four inch screw line pipe. Gas line for Kansas point.
D. J. WILSON,
Box 489 Blackwell, Okla.

WILL BUY or trade in on other equipment gas and oil engines, all sizes.
American Southwest Equipment Co.,
1708 Commerce St., Dallas, Tex.

MANUFACTURING MACHINISTS

CRAGO CUT GEARS
Worthy of your confidence. General machine work. 1416 Walnut, Kansas City, Mo. Phone Harrison 7660.

BUSINESS OPPORTUNITY

ANY OIL PRODUCING COMPANY wants a reliable geologists to pick out places to drill for oil, write me. My work proves what I know. A. C. Jones, Box 303, Lancaster, Texas.

NEVER FAIL LOCATORS on oil & gas. Write for particulars. Redmon & Bulk, 312 Cherokee, Humboldt, Kans.

I HAVE the experience and solicit association with responsible parties with capital willing to join me in oil propositions of merit. Robert Berney, Owensboro, Ky.

WILL GIVE ONE-HALF interest in NW ¼ of 25-20-10 and SE ¼ 25-20-10 for Turkey Mountain test. Good geology. Bartlesville gas production offsets North and oil production southeast. Box 495, Sand Springs, Okla.

10,000 ACRES Hudspeth Co., Texas, for drilling contract. D. L. Cummins, Haskell, Texas.

BROKERS-SALESMEN
Sound seasoned successful Royalty Company wants expansion capital easy selling issue. Pays monthly dividends, revolving depletion fund insures dividends. Full co-opertaion, many repeats. For particulars, write E. F. Hyland, 1118 Detwiler Bldg., Los Angeles, Calif.

FOR SALE—200 acre well improved stock ranch in oil section near Longmont. Leased for oil. Owner, M. M. McGillivray, Longmont, Colo.

CAPITAL—An experienced dependable broker with following will aid in financing a worth while proposition. B. W. 810 Broad St., Newark, N. J.

ANYONE WANTING a good wildcat oil proposition, machinery on the ground, address P. O. Box 0336, Cleveland, Tex.

A ST. LOUIS OIL COMPANY
Well established and completely equipped storage plant, tank and delivery trucks, service stations, etc.; excellent personnel; distributors nationally advertised brand gasoline and oil. A real buy. Address Box B-880, The Oil and Gas Journal, Tulsa, Okla.

FINANCE your project with stock bonded. Quickest and most satisfactory known method of raising capital. Information free. Bankers Interstate Security, Electric Bldg., Denver, Colo.

OIL DIRECTORY giving complete information on the entire petroleum industry in Arkansas; listing producers, refineries, operators, contractors, supply houses and kindred lines. Price $2.00. Millers Directory, Box 257, El Dorado, Ark.

WILL GIVE 2,500 acres for test Laredo District. A. B. Crosby, Laredo, Texas.

PROVEN LOCATORS — Guarantee never fails, on oil or gas, wildcatting our specialty, depth and sands, for particulars, write Redmon & Bulk, 312 Cherokee, Humboldt, Kans.

COMPETENT well-known salesman, executive, organizer ,would represent manufacturer of established line in Kansas Oil territory. Box B-873, The Oil and Gas Journal, Tulsa, Okla.

BUSINESS OPPORTUNITY

MANUFACTURERS needing capital on small bond issues, investigate my proposition. Extensive clientele. Commission basis. Write G. Pickhardt, 4631 N. Racine Ave., Chicago, Ill.

WANTED

WANTED—Equipment of merit for representation in Oklahoma.
W. A. SAWDON
Engineering & Equipment
220 Central Natl. Bank Bldg., Tulsa, Ok.

WANTED—Leases, royalties and production to sell. Waltman, Barnsdall, Ok.

WANTED—Capitalist or company to help develop proven oil field in Alberta, Canada. Dome formation, oil shallow. If you are reliable and mean business, write Box B-861, The Oil and Gas Journal, Tulsa, Okla.

ADVERTISING RATES

	1 Time	2 Times	3 Times	1 Mo.
3 lines	1.05	1.80	2.55	3.30
4 lines	1.40	2.40	3.40	4.40
5 lines	1.75	3.00	4.25	5.50
6 lines	2.10	3.60	5.10	6.60
7 lines	2.45	4.20	5.95	7.70
8 lines	2.80	4.80	6.80	8.80
9 lines	3.15	5.40	7.65	9.90
10 lines	3.50	6.00	8.50	11.00

(Six words usually make a line.)

Compute white space at the above rates. Mail your advertisement to

THE OIL AND GAS JOURNAL

Tulsa, Oklahoma

WANTED—Shallow production, Okla. or Texas. Must have a reasonable amount of undeveloped acreage, give age and full description in your first letter. Will purchase from owners only. Box B-870, The Oil and Gas Journal, Tulsa, Okla.

HELP WANTED

FOREIGN WORK MEN interested in oil, mine, railway work., etc., in South America, write at once. South American Service Bureau, 14,600 Alma, Detroit, Mich.

POSITION WANTED

FORMER PURCHASING AGENT of large Oil Corporation desires similar position or sales connection. Can report immediately anywhere. Age 30. Address Box B-890, The Oil & Gas Journal, Tulsa, Okla.

PRODUCTION SUPERINTENDENT 25 years experience in all fields where different sands are encountered, familiar with all details and geology; desires change; best references. Box B-896, The Oil and Gas Journal. Tulsa, Okla.

RELIABLE MAN WITH twenty-five years experience in all branches of the oil business except refining wishes connection with progressive oil company either here or abroad. Can give best references in Mid-Continent field. Four years experience in Mexico and South America. Box B-895, The Oil and Gas Journal, Tulsa, Okla.

COMBUSTION ENGINEER. Technical education. Four years refinery combustion and operating experience. Box B-891, The Oil & Gas Journal, Tulsa, Okla.

POSITION WANTED

CHEMICAL engineer and refinery superintendent with over 22 years' experience in European and American crude oils, specialist in lub oils and high vacuum distillation, desires change. Best references. Box B-736, The Oil and Gas Journal, Tulsa, Okla.

FIELD SUPT. with 17 years experience in domestic and foreign fields, wishes connection with reliable company. Or would consider taking a lease of shallow stuff where production is run down. Must have necessary equipment on ground. Box B-893, The Oil & Gas Journal, Tulsa, Okla.

PRODUCTION Superintendent 20 yrs experience with cable and rotary tools in Okla., Ark., and Louisiana; can handle any kind of air, or pumping production on any kind of formation. Best references. Box B-875, The Oil and Gas Journal, Tulsa, Okla.

PATENT ATTORNEYS

PATENTS—Oil well cases a specialty. Reliable services by an experience practitioner devoting personal attention to each case. References to oil well clients in Tulsa. B. P. Fishburne, Patent Lawyer, 550 McGill Bldg., Washington, D. C.

REGISTERED PATENT ATTORNEYS
United States and Canada
Before disclosing your invention to anyone, send for blank form.
Evidence of Conception
Bulletin "How to Establish Your Rights" and complete information free.
LANCASTER & ALLWINE
240 Ouray Bldg., Washington, D. C.

MONEY RAISING

DO YOU NEED MONEY for organizing or financing oil or mining deals? Write 131 E. 13th. Oklahoma City, Okla.

OIL INDUSTRY PRINTING

CONSUMERS' LEDGERS
We are prepared to furnish from stock standard forms of gas meter Consumers' Ledgers. Sample forms and quotations on request. First-class material and workmanship.
DERRICK PUBLISHING CO.
Oil City, Pa.

DO YOU WANT to better yourself? Every week men are placed in responsible positions at good salaries through ads in this classified section.

OIL FIELD LEGAL BLANKS
Leases, assignments, releases, township books, well records, etc. Request on your letterhead gets free catalog. Olds Press. 215 East Third St., Tulsa, Okla.

HOTELS

TEXAN HOTEL, Pampa, Texas. Heart of Panhandle oil field. Modern. Reasonable rates. Family style meals.

INCORPORATIONS

CHARTERS—Delaware best, quickest, cheapest, most liberal. Free forms. Colonial Charter Co., Wilmington, Del.

DELAWARE incorporators. Charters fees small, forms. Charles G. Guyer, 901 Market St., Wilmington, Del.

FOR SALE—PETS

PUREBRED PERSIAN KITTENS, finest type, color bred. For choice, write Red Persian Cattery, 235 Station A, Dallas, Texas.

PEKINGESE PUPPIES, little beauties; all from the finest imported stock; some as low as $40. W. 2115-W or write Mrs. Murray Brooks, P. O. box 306, San Antonio, Texas.

GUINEA PIGS WANTED 8 ounces or over; rabbits, 3 pounds or over. Canaries all kinds, for cash. Schreiner, 301 N. Cardinal, St. Louis, Mo.

35 CENTS a line first insertion; 25c a line each additional insertion. Cash in advance.

CLASSIFIED WANTS

CREATE AND BUILD BUSINESS

MAIL your advertisement now. It will be published next week. Cash with order.

SUMMER RESORTS

SPEND THIS SUMMER IN THE OZARKS

Will rent, June to September, 9 room furnished, located in beautiful oak grove on 40 acre plot adjoining Bella Vista, Golf Course, Bella Vista, Ark. 3 sleeping porches, 2 sleeping rooms, large living and dining rooms, bath, sewer, Delco lights, private swimming in pure spring water in "Ye old swimming hole." Mr. & Mrs. Geo. M. Swift, Directors "Dellwood Camp for Girls," Dellwood, N. Carolina. Telegraphic address, 81 N. Liberty St., Ashville, N. C.

ONE HALF mile Wisconsin lake shore, 50 miles from St. Paul; property extraordinarily beautiful and attractive for single owner or colony; three fiine dwellings ready for occupancy; fishing the best; no trading. For particulars apply to Wm. McMurray, 283 E. 5th St., St. Paul, Minn.

ROYALTIES—PRODUCTION

FOR SALE—Royalty in Seminole County, 20 acres (¼ undivided 80) S. E. 31-10-7 E. Subject to prior sale by owners. No brokers. Address J. A. Lull, The Ktchum Hotel, Tulsa, Okla.

SMALL TRACTS ROYALTIES

and leases along the Pecos, West Texas

WATSON
Room 922,
30 North Michigan Ave.,
Chicago, Ill.

FARM AND ROYALTY, 80 acres, 14 miles north of Tulsa; one and one-half miles from pavement; producing wells; good land; for quick sale, by owner, $8,000. Address Box B-892, The Oil & Gas Journal, Tulsa, Okla.

FOR IMMEDIATE acceptance, will sell one-sixteenth of the royalty under Section 24, Block 77, Winkler County, Texas. H. T. Jones, 5302 Ridgedale St., Dallas, Tex.

FOR TRADE—Royalties in promising locations, Ward and Reeves Counties, Texas, for royalties elsewhere. Lee Monroe, Topeka, Kans.

J. F. MARION OIL COMPANY
Magnolia Building
Dallas, Texas
Buys and sells Texas Oil Leases and Royalties.

FOR SALE—ROYALTIES
Which are close to production.
10 acres, 19-7-4; location for well already made on this tract; $1,300 per acre.
20 acres, 20-7-4; $550 per acre; lease expires April 11, 1928.
7 acres, 28-7-4; $400 per acre.
2¾ acres, 28-7-4; $350 per acre.
7 acres, 17-8-3; $100 per acre.
40 acres, 17-8-3; $100 per acre.
40 acres, 21-7-4; $600 per acre.
There are great opportunities in Shawnee to make money in business property. Let us show you.
Anything you desire in close up royalties. Columbus took a chance, why not you? Nothing risked, nothing gained.
COLE & MOORES, Realtors
Walcott Hotel Lobby, Shawnee, Okla.

NOTICE
Offering undeveloped and producing royalties, leases and drilling blocks. Brown (Fry Field area), Coleman, Callahan and Shackelford Counties, Texas.
All offerings submitted will be accompanied by geological information.
M. ELDER & COMPANY
Coleman Hotel Bldg., Coleman, Tex.

LEASES and half royalties, Caddo, Blaine and other counties. Write for complete list. A. E. Baldwin, Anadarko, Okla.

ROYALTIES—PRODUCTION

KEVIN-SUNBURST LEASES and royalties; structures with good geological report for the drilling of a well. Ridgeway & Charles, Shelby, Mont.

LEASES—PRODUCTION

WILL LEASE my 800 acres fee lands, 6n-2w and 6n-3w McClain County, Okla. Reasonable. Joe P. Crawford, Okla. City, Okla.

DRILLING BLOCK secured on approved acreage and well supervised; no bonus; we keep some acreage as fee. Nicolle, Petroleum Geologists and Operators. Box 1720, Fort Worth, Tex.

SOUTHEAST NEW MEXICO
Can furnish practically proven leases in Artesia Field, Eddy County. Also other tracts in Eddy, Chaves and Lea Counties. Particulars on request.
H. T. ORCUTT
1114 Colcord Bldg., Oklahoma City, Okla.

FOR SALE in Breathitt County, Kentucky, 2,000 acres, six wells, present production 20 barrels; all proven territory. Plenty of gas for operating.
E. D. WATKINS
Irvine, Ky.

"IN THE TREND"
Southeastern New Mexico and West Texas counties — Lea, Eddy, Chaves, Gaines, Andrews, Winkler, Loving, Ward, Culberson and Pecos Counties, oil and gas leases, royalties and drilling blocks. We buy and sell. F. S. Blackmar, P. O. Box 541, Roswell, N. Mex.

FOR SALE—143 acre lease; one well just completed; 38 gravity; depth 900 feet; good market. Box 378, Cherryvale, Kans.

FOR SALE—Selected oil and gas leases adjoining producing and drilling leases in Barron County, Kentucky. At right prices. J. C. Preston, Glasgow, Ky.

OIL AND GAS LEASE FOR SALE
On 1920 acres Brewster County, Texas, ten year lease, ten cent rentals, twenty cents (.20c) per acre bonus, total $384.00. Mid-Kansas and others have contract to drill wildcat wells in this county which adjoins Pecos where the Yates pool produces ten thousand barrel wells at shallow depth. Telegraph for this.
J. S. Jones, First National Bank Bldg.,
Fort Stockton, Texas

IF YOU buy or sell royalties, leases or production you should not overlook The Oil and Gas Journal Classified Wants. They comprise the best medium of exchange available to you.

4,000 ACRES in Frio County, near Moore in line with producing wells in Medina County. For sale in fee, $25 acre, good possibilities. E. Smith, 134 Devine Street, San Antonio, Texas.

DRILLING CONTRACTS in Louisiana, Tyler County, Texas, and Amarillo field. Box 653, Kansas City, Mo.

FOR SALE—Oil leases in Cimarron, Texas, Beaver and Woods counties. Orbee Lease Co., 1114 Colcord Bldg., Oklahoma City, Okla.

TEXAS OIL LAND—Have 10,000 acres; lease or part for drilling. Owner. Box 944, Long Beach, Calif.

FOR SALE
Nonresident Owner Wants Offer
4,447 acres Freestone County; 15 miles southeast of Teague on highway. In live oil territory not leased. R. Rutherford and J. Sanchez surveys north line. L. Duel, south. Plum Creek runs through this land north and south. Have oil map showing fault line runs with creek. Fenced and cross-fenced. 900 acres in cultivation; balance good oak timber; 85% tillable; 12 sets improvements—some old. One 2-70 saw gin plant, small store and commissary. On terms. A chance to make some money. No trade.
H. H. JACOBY
1007 Republic Bank Bldg., Dallas, Tex.

VAL VERDE County, on Pecos River, is next big play. Let me send you my list of exceptional values. L. W. Stieren, 815 Alamo Bank Bdlg., San Antonio, Tex.

LEASES—PRODUCTION

HUB AND SUPPLY CENTER
Of The New
"Marvelous West Texas Oil Fields"
Comprising
Crane, Upton, Pecos and Crockett Counties
Buy a town lot in McCamey—Leases and Royalties for sale.
F. A. HORNBECK CO.,
McCamey, Texas

LEASES around the V. T. Bolin well in Howard's Draw, south central Crockett County, Texas, in direct trend from Yates Field across river in Pecos County. Well fully financed and now setting 10-inch casing at 2,110 feet; contract depth 3,500 feet. Write for maps, prices, etc. V. T. Bolin, 510 Floyd Holmes Bldg., Fort Worth, Tex.

FOR SALE — About 20 bbls. settled production in old field in Allen County, Ketucky, about 3 miles from Scottsville, Ky. About 10 wells equipped and pumping, and is 12 years old. Address Box No. 94, Scottsville, Ky.

OIL LEASES and royalties, Ector, Crane, Pecos, Reeves, Ward, Upton and Winkler Counties; buy or sell. C. H. C. Anderson, 712 Linz Bldg., Dallas, Tex.

WINKLER—PECOS COUNTIES
Leases and Royalties
W. S. PATTERSON
Pecos, Texas.

ADVERTISING RATES

	1 Time	2 Times	3 Times	1 Mo.
3 lines	1.05	1.80	2.55	3.30
4 lines	1.40	2.40	3.40	4.40
5 lines	1.75	3.00	4.25	5.50
6 lines	2.10	3.60	5.10	6.60
7 lines	2.45	4.20	5.95	7.70
8 lines	2.80	4.80	6.80	8.80
9 lines	3.15	5.40	7.65	9.90
10 lines	3.50	6.00	8.50	11.00

(Six words usually make a line.)

Compute white space at the above rates.

Mail your advertisement to

THE OIL AND GAS JOURNAL

Tulsa, Oklahoma

KENTUCKY leases on structure, low price and liberal terms. A. W. Richards, Center, Ky.

For Sale
OIL
LAND OR LEASE
Crane County
Texas
640 cares, Crane County, one half mile frontage on Pecos River, Southeastern part County, proven oil country. Leads in production. Section 8, Block No. 1, Certificate No. 40-4750. Crane County, Texas.
WRITE J. E. SHERMAN.
Falfurrias, Texas.

I HAVE for sale, lease or option, 200 acres of land, with good oil showing in several places on the surface. May be inspected at any time. Write or see me for particulars. W. B. Hartsell, Marquand, Mo.

FOR SALE—Leases and production in Warren, Allen and Barren Counties. Have leases in Barren County joining producing leases and some within half-mile to 1 mile of production. W. P. Harley, Bowling Green, Ky.

LEASES—PRODUCTION

A PROMOTERS BONANZA
15,000 acres, Brewster County oil and grazing land, on State Highway, well fenced and watered, good grass at $1.50 per acre, bonus, including oil rights. McCrary Realty Co., 511-13 Rust Bldg., San Angelo, Texas.

ALLEY, SMITH & PARKS
Crane and Ector County Surveyors
Civil Engineers
COURT HOUSE, ODESSA, TEXAS

500 ACRES BETWEEN 4 producing fields. Fee. No Lease. Adjoining lands leased. Side track & R. R., Pipe lines on land. Chas. Brown, 6012 Brady St., Houston, Texas.

EXTEND your business in the oil industry by advertising in the Classified Wants Section of The Oil and Gas Journal.

FOR SALE AT a sacrifice: 240 acre oil lease in shallow field of Kans. Production around 10 bbl. will sell on test. Two sets equipment. Best bargain in shallow field. Write A. B. Webb, Paola, Kans.

221-acre ten year oil lease. Same block with 4,000 foot test now in lime at 3,200. Also joins California Standard lease.
M. F. BEAUMONT, HARTLEY, TEX.

25,000 ACRES Brewster County about 16 miles Southwest Alpine, Texas, patented land minerals intact. Oil men of opinion Brewster will produce plenty of oil. $2.50 per acre. F. P. Simpson, 517 Worth Bldg., Fort Worth, Texas.

BARGAINS IN New Mexico State leases, straight leases and government permits all over State. Prices range from 50c per acre up. Advise in detail your requirements. WYLIE & BLINEBRY, 319 Martin Bldg., El Paso, Texas.

The undersigned will offer for sale, 80 acres of oil land, not leased, in the Southeast of 7-24 North Range, West in Noble County, Okla., for one hundred and twenty five an acre. Address of owner. A. J. Sauer, Box 566, Lancaster, Calif.

SOUTHWEST TEXAS — WINKLER, Loving, Reeves, Ward, Pecos, Culberson Counties.
Drilling blocks. Leases. Royalties. Ranches in fee.
H. F. Anthony, Pecos, Tex.

FOR LEASE — Abstract Furnished 164 Acres, Andrew Kent Survey, Smith County, Tex. $7.50 per acre.
A. E. OWENS, 211 Ward Bldg., Shreveport, La.

TO THE SMALL INVESTOR

The average success in wildcat drillings is one producer out of every four tests.

For $10 I'll agree by contract to carry you in on a one-fortieth interest in four 40-acre New Mexico leases estimated to be located on structure and near drilling wells in four different counties.

I will pay the expenses and pro rate the ultimate profit when leases are sold.
CHAS. E. PARROTT
Arcade D, Amarillo Bldg., Amarillo, Tex.

DRILLING blocks, good geology, also acreage near drilling well, Runnels County, Texas; trend of production. C. E. Sillix, Ballinger, Tex.

WRITE, A. M. Sullivan, Coahoma, Texas, for oil leases and royalties in Howard County, Texas, the coming oil field of Texas.

LEASES—AIR COMPRESSORS
Twelve hundred acres Adair and Cumberland Counties, Kentucky, under lease adjacent to production, would sell outright or reserve interest with responsible operator. Have two steam driven Imperial Type X, Ingersoll Rand Air Compressors 12x15x12x6¾x16, used ninety days. Sell at reduced figure.
CRAWFORD & SEBASTIAN, INC.
618 City Bank Bldg., Shreveport, La.

Chicago Market Opens Week Quiet

Moderate Business as a Whole. Spot Demand Only Fair. Dealers Slow to Give Shipping Instructions

By J. B. Waldo

CHICAGO, June 13.—Monday did not maintain the good record of the latter part of last week as the market opened with a quiet tone and only a moderate business as a whole. The spot demand for gasoline was only fair and there was nothing in the opening day of the week to indicate that the jobbers were in need of immediate supplies. Some refiners state that even on contracts the dealers are less prompt to give shipping instructions than they have been. The price situation was unchanged with the exception that two refiners who had been holding for 7 cents dropped back to the prevailing and almost the only price for U. S. Motor gasoline of 6¾ cents. There was no change in the higher gravities Monday and the demand was very limited.

Kerosene was weaker in tone and the average market dropped back to 4¼ cents with sellers seeking business at that price and not holding very strongly to their quotations.

The gas oil situation was strong and there was considerable inquiry largely from dealers who are looking forward to the coming season. In several instances contracts which had been submitted were stated to have been signed and returned. These contracts are at the market price with a maximum and minimum. Some of the fuel oil buyers were feeling out the market. There are several large contracts yet to be written with local concerns that are hanging fire and the buyers in the meanwhile supplying their immediate needs in the open market.

The weather was fair but very cool for the season over the week-end with light local rains on Monday.

Better Motoring Weather

Weather reports and farm and road conditions are so important to the gasoline market that they are discussed from every angle. There has been very little pleasure riding, almost no touring to date this year and the public is hungry to use its cars to get out into the open roads. This vicinity had some good days last week and the result was immediate. The city boulevards and parks and the highways out in the country were so jammed with motorists that there was very little pleasure in driving. Yet the public drove in droves. Wherever it was possible to motor at all there was a decided increase in gasoline consumption. There was a little more spot business. A few concerns reported they had a really fair business, others that they had a little better business than during the preceding week. The volume of spot business was not large but it was improving and even a little improvement increases the hopefulness of the dealer and gives him a brighter outlook on the business.

The price range all of the week was between 6¾ and 7 cents. There were more refiners selling at 6¾ cents, that is openly quoting that price, than at the beginning of the week. Only a few were holding for the 7-cent price and nearly, if not all of these, have a grade that is rated as better than the standard U. S. Motor grade. It was said of these refiners who held to a 7-cent price that they held that price for their super gasoline while selling their regular U. S. Motor gasoline at 6¾ cents, to meet competition. The bulk of the requirements of the country dealers and the city dealers for that matter is being cared for by contract deliveries. They do not generally need more gasoline but in some cases it was stated that some dealers with contracts were now ordering extra cars from their regular source of supply which is in a way buying in the spot market at an established price. There is, as always, not the least doubt that if the roads are usable there will be a greatly increased consumption of gasoline from now on. It is the weather that has the edge on the gasoline business.

Farming Conditions

Right now the reports indicate that for once at least, the Northwest, including much of Wisconsin and Minnesota, the Dakotas and Nebraska, are having plenty of moisture to give the crops a good start. In fact, one oil man serving a considerable territory in the Northwest says that his reports indicate the best conditions for the time of year in five years at least. In the states bordering on the Mississippi River conditions are bad and Illinois is in about the worst shape of any of the Middle Western states. Even now the southern part of the state is threatened with another flood and the Illinois River is very high and rising. Thousands of acres of as fine crop land as there is in the country have not been plowed and other thousands are just being plowed, and will be planted to 90-day corn, which would be caught by an early frost or damaged by a midsummer dry spell so it is an uncertain crop in this latitude.

We may expect that the early improvement in the gasoline demand will come from the country districts of the Northwest. The city trade is good to excellent pretty much everywhere in this territory. The use of the auto is increasing rapidly in many ways and each season sees it displacing more and more horse-drawn vehicles as well as finding new uses.

Spot Market

The spot market demand is almost entirely for the U. S. Motor grade. There is almost no demand for the 56-58 450 and while a number of grades have been slipped in between the two former gravities with their 450 and 437 endpoints, they really mean little. There is quite a demand for the 400 Navy or more precisely the 60-62 437 or better endpoint. This gravity is called for by some of the state regulations and it also competes with the gasoline sold regularly by so many stations of the larger companies as The Texas Company, Marland, Shaffer, Johnson and the like who supply their own stations at least with a gasoline that has the 60-62 400 specifications. The 60-62 437 endpoint or better, while nominally priced a little above the U. S. Motor grade, has sold at the same price here on several sales to large buyers. In one instance a sale was made at 6⅝ cents and another quotation was made of 6½ cents by fairly large Group 3 refiners. The 64-66 375 endpoint was reported to be sought by the Atlantic Refining which was taking options from north Texas refiners and it was stated the prices named ranged from 6¾ to 7 cents. There was no special activity in this market on these gravities and it seems evident that the antiknock or super gasolines are taking the place of the higher gravities. Natural gasoline has been quiet and prices a little lower than a week previous.

Kerosene Buying

Kerosene, according to some oil men, is due for a larger demand in the near future and there has been some buying by refiners with their own distribution. The idea is that the farmers in many parts of the territory are just getting onto their fields and are rushing their plowing and seeding, working nights as well as days and using their tractors as much as possible. This means a considerable increase in the consumption of tractor fuel. There is no doubt that this is being done but country dealers and larger distributors have bought quite heavily of kerosene and as they realize that the season of active demand will be brief, they are not likely to order before their stocks are much reduced and some doubtless will not be obliged to order for this increased demand, having provided for a larger demand than they had earlier in the season. The price for the 41-43 gravity has dragged along at 4⅜ to 4½ cents with a tendency at some times to shade the lower price for business. Some of the larger business has been taken at 4¼ cents and even less occasionally. There is very little call for the 42-44 gravity.

Distillate Contracts

Some of the distillate distributors in this and nearby cities report that their contracts already booked with consumers number twice as many as at the beginning of last season. Locally one of the large distributors has announced that the company would not seek any furnace oil business this year but confine its sales to industries. This may account for some of the increase in business done by other distributors but there is evidently a larger demand ahead for furnace oil than a year ago because of the additions to the number of oil burners installed during the past year and conditions as to the installing of more burners this year are very favorable. Several of the larger burner manufacturers report their advance business with agents has been much larger. One thing that will help the sale of burners is the success which many have made of their burners last year. There is a constantly increasing list of satisfied users to refer to. Besides this the price of furnace oils is a little lower and there are several makers of domestic oil burners that have announced the production of a smaller and less expensive burner adapted for the use of the smaller type of dwellings. This will help with the installing of burners and increase the sale of furnace oils.

The distillate demand has been light but there are numerous inquiries for contracts and some are being made with distributors by both refiners and marketers, usually at the market date of shipment with a minimum and a maximum price. The refinery market for distillates has been stronger and most refiners are unwilling at present to make contracts except those based on the market date of shipment although some sales for delivery over the winter at a fixed price are stated to have been made with advances in price as the months of larger demand are reached. The sellers in this market are still quoting 3 to 3⅛ cents for the 36-38 distillate and 3¼ to 3⅜ cents for the 38-40 distillate. The real distinction between the different grades is in the flash and cold tests and some of the sellers are naming the lower price for distillate with a flash of 180 to 200 and the higher price for a distillate of 170 degrees or lower.

Gas Oil Strong

Gas oil is strong in this market, especially for the qualities suitable for furnace oils. There is considerable buying and some storing by jobbers of these oils where the specifications make them suitable for furnace fuel. Eldorado refiners have advanced the price of their straw gas oil from 3 to 3¼ cents and some of the buyers state they have been unable to purchase a good gas oil for furnace use at less than 3 cents while others have found some oil available at 2⅞ cents. Several refiners here have stated they were holding their gas oil and should continue to do so. Where they are now operating their cracking plants the refiner is holding his cracked gas oil for winter distribution for oil burner use. Where the refiner is not operating his cracking stills, they are holding their straightrun oil for a possible increase in demand for gasoline which might cause the refiner to start his crackers.

There are some dealers and larger users of gas oil who believe that an increase in the demand for gasoline would result in a larger supply of gas oil because of the greater volume of crude run by the skimming plants. One refiner with a good skimming plant said he was making money at the current market and running five cars of gasoline daily and that if the gasoline price would hold at 7 cents and possibly go to 7½ cents he would run all the crude he could and probably reach an output of 15 cars of gasoline daily. This would mean that he would treble the output of gas and fuel oil and the trade believes there are many other refiners who would do the same thing. The new business reported with the gas companies is stated to be from small concerns, the larger operators having bought or made contracts for their supplies for a period and are not in the market at present. These use the dark gas oil and the market for this grade is not as strong as for the lighter oils but is still firm. There is only a limited demand from the industries.

Fuel Oil in Rut

Fuel oil shows little signs of any immediate change from the rut in which the market has traveled for some months. Two large steel local companies have been reported as in the market for annual contracts and it has even been stated they had closed a deal for another year. It is now stated by good authority that they do not intend to contract at present unless they secure some offers at decidedly better terms than they have had so far. Heavy buying of rails is stated to have enabled at least two steel companies to avoid a summer shutdown for lack of orders but generally it is more the question of costs than of business that is causing buyers to hold back on placing contracts. Some concerns with assured business for the remainder of the summer and the early fall are placing hand-to-mouth orders. What they are looking for is another crude cut and a lower basis for prices. Considerable railroad contracting has been done on the basis of a percentage of the crude price with a minimum and maximum. It is believed that these railroad contracts have contributed largely to making the strength that has developed in the market for the heavier oils.

Substantially the refinery prices are 90 cents for the heavier oils, some say that that is the only price for 24-26 and lower gravities while the better grades are held for $1 but here all sorts of prices are quoted. One large distributor is reported to have sold a large quantity of fuel oil at 80 cents, backing his belief that the fuel oil market would move downward, and is not finding any oil available at that price. The more conservative dealers have never believed in the continued decline in the markt and say that until the first of July at least present prices will hold. The bulk of the new business is still being done in small quantities. Some buyers are talking of making contracts but the inquiries for the most part seem to result in decisions to continue their purchases in the spot market for a while.

Lubs Unchanged

Lubricating oils are unchanged with perhaps a little more demand from the jobbers for motor oils and in some parts for heavy tractor oils. Prices are unchanged although there is much cutting of prices. One sale of a large quantity of red oil is reported at 10 cents delivered in Chicago for a 200 viscosity oil that is listed by Oklahoma refiners at 10½ cents. Group 3. There is considerable complaint regarding the quality of oils furnished by several refiners who have been very outspoken in their criticism of the price-cutting methods of other refiners

and generally there is a good deal of "passing the buck," and mutual recrimination between sellers of lubs. Those who seem to be best pleased with their business this season are those who have made a fine grade of lubricating oils and have sold their quality product at a good price and held to it. There are many indications that a large number of motorists are realizing the necessity of using good oils and that it pays them to do so. There seems to be little change in the industrial oils and specialties for industrial use.

Price Cutting

One of the outstanding features of the situation is the determined price cutting that is going on all over the territory. Early last week the normal prices at Minneapolis were further reduced by a cut of 2 cents, making the station price 16 cents. Almost immediately several stations put out a price of 15 cents and some made a price of 14.9, all including the state tax of 2 cents. Late in the week the Standard reduced its price at Kansas City and at Duluth by a 2-cent cut. These cities are almost at the extremes of the territory as regards location. Illinois and Indiana have been more free from price reductions below the normal than other parts of the territory but it is increasing even in these states, while there seems to be no abatement of the trouble elsewhere. All through Iowa there are price cuts and reports from southern Minnesota indicate there is an equally bad situation there. Locally, the market is unchanged but in the important manufacturing centers that are a part of the Chicago district, Gary, Hammond and East Chicago, the situation shows no improvement as the result of a 3-cent drop in the station and tank wagon market. Each of the three large local refiners has a distributing or resale agent and these are protected by the discount allowance for quantity so that it makes no difference to these agents or distributors how low the tank wagon price goes, their margin is undisturbed. It would seem to be impossible for more stations to be profitable yet to "keep pace with the growth of the city," as they say, new stations are being built in some cases by companies who say they have stopped their expansion program, only completing those stations for which contracts had been let. There are a lot of new stations being opened and some at points at which it would seem they would never make a profit. This is a good deal like the building of skyscrapers all over the city. Many of the new and older office buildings alike are only half filled and renting agents say that this season there has been less call for office space than in many years. Yet the central part of the city is being rapidly rebuilt with towering structures of 20 stories or more and in the outlying business districts there are many such buildings. The manager of a large real estate firm that has the renting and management of several such large Loop buildings says that they plan it will take at least five years before new buildings can be made to pay. Perhaps some of these newer service stations will make a profit at the end of such a term. In the meantime, like the management of the office buildings, all sorts of inducements are used to bring in more business.

PARKER HEADS TEXAS GAS AND OIL DIVISION

AUSTIN, Tex., June 11.—R. D. Parker, head of the gas utilities division of the railroad commission for nearly seven years and connected with the commission since 1909, was unanimously elected as chief supervisor for the oil and gas division to fill the vacancy caused by the resignation of Judge H. E. Bell, effective June 23.

Parker came to the railroad commission 18 years ago as engineer, serving in that capacity until 1920 when he was appointed head of the gas utilities division after its creation by the legislature.

Clarence E. Gilmore, chairman of the railroad commission, accepted Judge Bell's resignation reluctantly and with regret, "with a full appreciation of his splendid services to the state and the commission."

GASOLINE MARKETS IN THE EAST UNCHANGED AT BOTTOM PRICES

By N. O. Fanning

New York Bureau, The Oil and Gas Journal, Room 629, No. 101 Park Avenue, New York, N. Y.

NEW YORK, June 10.—The eastern gasoline markets are unchanged, with prices at bottom. However, there have been tendencies noted toward improvement in several directions. It is said to be the belief of eastern refiners that refinery and tank wagon prices have been cut in line with crude reductions, and that unless further cuts in crude occur, no further cuts in gasoline prices may be expected. This is indicated by the apparent steadiness of eastern quotations at present levels.

The Standard Oil Co. of New Jersey during the past week advanced export gasoline in cases one-half cent a gallon, making the second half-cent advance within a month, or a total gain of 1 cent over the low price of 23.90 for this year. This is certainly a favorable indication.

The weather has been much more favorable in the East and gasoline consumption has reflected this accordingly. As a result, eastern refineries are said to be speeding up operations somewhat, although it is not known whether cracking operations have been affected or not.

A reduction in the tank wagon market for gasoline in New York City has been expected for some time, but in as much as it has not yet arrived there is a question whether it will come at all or not. There does not seem to be excessive competition here at present, and indications are the situation as to prices is well in hand.

California a Factor

California gasoline is coming in on an increasing scale. Several cargoes arrived last week, and the aggregate receipts were estimated at something like 20,000,000 gallons. The largest part of the oil coming in from the Pacific Coast, however, is said to be fuel oil. During the week ended June 8 approximately 1,281,000 bbls. of crude and refined oil arrived from California. For the month of May the receipts from California totaled about 1,801,000 bbls. Of course, the weekly figure is not indicative of the average rate, but it indicates no letup in the movement from California to the Atlantic Seaboard. Another evidence of the same outlook is the fact that activity in the tanker charter market in the California trade is growing.

Kerosene Unchanged

The kerosene market on the Atlantic Seaboard is unchanged. Competition is keen in some sections, where cheap imported kerosene is being sold. In the interior prices are much more firm, however. Demand is good.

Gas and Fuel Oil

The gas oil and fuel oil markets are settling down on the new and lower price basis, with demand fair. Stocks on the Atlantic Coast have been added to by large imports and receipts from California, so that there is no trouble supplying all current business, as well as oil already contracted for. The most interesting feature of the fuel oil price situation is the effect it may have on low-grade crudes. Some oil men believe a 10-cent cut will follow the general reduction in fuel oil recently put into effect on the Atlantic Seaboard.

Lubricating Oils

The market for lubricating oils is firm, with little change in the general situation. Consumption shows a good seasonal increase, and buyers are stocking up in anticipation of a possible improvement in refinery quotations.

Paraffin Wax

Wax prices show no material improvement. The domestic market is fairly active. Buying for industrial account is falling off somewhat. This is attributed to the summer lull in activity.

Petrolatum

The petrolatum market is unchanged. Western Pennsylvania refiners continue to offer all grades freely. It is reported that sales in that territory of dark green are being made as low as three-quarters of a cent a pound.

Export Situation

It appears that the Russian oil interests may withdraw from the United Kingdom in the near future. The elimination of Russian oil from that market would result, it is believed, in material improvement in the trade there.

During the past week the export movement from New York was heavy. Bulk shipments to Europe of gasoline and kerosene exceeded 5,000,000 gallons.

A feature of the market was the shipment of a bulk cargo of lubricating oil to Brazil. This calls attention to the growing importance of the South American trade, which has always been largely a cased oil affair.

Exports of paraffin wax continue below normal. There is a fairly good demand for crude scale but even this department is falling behind.

Petroleum asphalt shipments during the past week were exceptionally large, exceeding 10,000 tons. This total was about equally divided as between Europe and Australia. Germany took almost all that consigned to Europe.

The following table shows principal exports of petroleum and petroleum products from New York during the past three weeks (all figures in gallons unless otherwise noted):

	Week-ended		
	June 8	June 1	May 25
Gasoline:			
Bulk	2,515,000	.....	7,085,804
Cases	645,700	1,518,750	391,990
Kerosene:			
Bulk	1,194,700	.....	9,320,590
Cases	565,930	1,433,840	2,434,260
Gas oil:			
Bulk	.....	.....	1,114,344
Fuel oil:			
Bulk	904,772	.....	.....
Lubricating oil:			
Bulk	2,697,190	.....	2,633,877
Bbls.	1,142,350	404,300	1,157,950
Cases	95,980	195,540	93,340
Lubricating grease:			
Bbls. (lbs.)	181,925	.....	396,000
Paraffin wax:			
Bags (lbs)	308,000	640,640	1,405,140
Bbls. (lbs.)	408,925	181,450	1,758,925
Petroleum asphalt:			
Bbls. (tons)	10,644	200	804

The foregoing fiugures include shipments of 500 bbls., 1,000 cases or more.

Oil Tanker Market

Oil tankers are now in demand, but current rates being paid for charters show a sharp decline. A fixture for the Gulf-Atlantic trade at 31 cents compares with 36 cents reported paid less than two weeks ago. California-Atlantic fixtures are reported at 84 cents, against $1.03 reported a little more than a week ago. The lower rates are attributed to the fact that many charters are expiring, releasing vessels for the trade. In addition, it is reported several new tankers have been launched from the ways recently.

New fixtures include the following:

Tanker Birkenhead, June loading, San Francisco to Boston, 70,000 bbls., 84 cents a barrel.

Tanker Topila, 50,000 bbls. crude, Gulf to north of Hatteras, 31 cents, or Tampico to north of Hatteras, 38 cents.

Tanker George H. Jones, north Atlantic to United Kingdom, gasoline, 35s., June loading.

Tanker Gene Crawley, 2,361 tons net, June loading, Tampico to New Orleans, two trips, 19 cents a barrel.

Tanker Pendrecht, 2,000 tons gasoline or kerosene, 12 consecutive voyages beginning August, Black Sea to United Kingdom, at 32s. 6d.

Tanker Gustav Schindler, 3,000 tons net, gas oil, July, Constanza to Cetta-La Goulette, June loading, 27s. 6d.

Tanker Marisedda, 2,000 tons net, clean oil, June loading, Constanza to Cette-La Goulette, June, 27s. 6d.

Oil Receipts Heavy

Receipts of crude and refined oil by water at Atlantic Coast ports for the week ended June 8 are estimated at 5,194,000 bbls., a daily average of 742,000 bbls., compared with 4,006,000 bbls., or 572,000 bbls. daily, the week ended June 1. Receipts were the largest for any week so far this year. Receipts from all sources were above normal.

Receipts from the Gulf Coast for the week ended June 8 averaged 392,000 bbls. a day, as compared with 362,000 bbls. the preceding week. Receipts from California increased to 183,000 bbls. daily, from 10,000 bbls. daily the week before.

Imports for the week ended June 8 were 1,170,000 bbls., a daily average of 167,000 bbls., of which 91,000 bbls. daily came from Mexico and 76,000 bbls. a day from South America.

The following table shows estimated daily average receipts of crude and refined oil by water at Atlantic Coast ports for the past three weeks; also monthly record for the past 12 months (figures in barrels):

	Week Ended		
	June 8	June 1	May 25
Gulf Coast	392,000	362,000	271,000
Pacific Coast	183,000	10,000	51,000
Mexico	91,000	131,000	53,000
South America	76,000	69,000	44,000
Total	742,000	572,000	419,000

Daily Averages by Months

1927:	Gulf	Pacific	Mexico	S. Am.	Total
May	332,000	58,000	91,000	53,000	534,000
April	388,000	93,000	69,000	61,000	611,000
March	345,000	103,000	36,000	81,000	565,000
Feb.	379,000	89,000	40,000	48,000	556,000
Jan.	362,000	73,000	49,000	61,000	545,000
1926:					
Dec.	363,000	57,000	49,000	61,000	530,000
Nov.	335,000	62,000	56,000	40,000	493,000
Oct.	270,000	71,000	61,000	43,000	445,000
Sept.	299,000	98,000	63,000	58,000	518,000
Aug.	320,000	61,000	71,000	46,000	498,000
July	360,000	66,000	115,000	36,000	577,000
June	396,000	104,000	117,000	18,000	635,000

The foregoing figures are based on the carrying capacity of incoming oil-laden tankers.

KANSAS FIELDS

(Continued from Page 52)

NE cor. Section 23-15-3, is dry and abandoned at 3,011 feet.

Greenwood County

Loy & Leader's No. 1 Oliver, SW cor. SE Section 26-22-11, is a dry hole at 1,998 feet. Scott and others' No. 1 Terer, NW cor. SE SE Section 15-23-9, has been abandoned at 2,425 feet. Flack and others' No. 1 McGinnis, NE cor. SE Section 26-26-8, had sand at 2,345-90 feet and drilled in to the lime to 2,560 feet and was abandoned. Murphy and others' No. 1 Edwards, NE cor. SW Section 7-26-10, drilled to 2,169 feet and then was plugged back to 2,166 feet and shot with 15 quarts and had only an 8-bbl. show and was then abandoned.

Lyon County

Jackson & Wise built the rig for No. 3 Bradfield, NW cor. SE NW Section 25-21-10.

McPherson County

The Texas Company's No. 1 Chinberg, NW cor. NE NW Section 32-18-2w, is spudding.

Morris County

Nicols and others have the machine at the location for No. 1 Southwick, NE cor. Section 14-17-7. The machine is at the location for No. 1 Wilde, NW cor. SE Section 15-17-7.

Reno County

T. B. Slick's No. 1 Dutton, SE cor. NW SW Section 25-26-9w, an old well deepened, has been abandoned at 4,507 feet.

Rice County

Phillips Petroleum Co.'s No. 1 Welch, SW cor. NE NW Section 35-20-6w, has sand 3,375-3,450 feet, drilled to 3,453 feet and made 25 bbls. Mississippi Valley Oil Co.'s No. 1 Trotter, C NE Section 34-21-7w, has been abandoned at 4,012 feet.

Russell County

Keys Petroleum Co. made location for No. 1 Baxter, SW cor. SE SE Section 32-13-15w.

Sedgwick County

Boyle and others' No. 1 Poff, NE cor. SW Section 6-25-1e, is dry and abandoned at 3,857 feet.

Sumner County

Marland Oil Co.'s No. 1 Tedger, NE cor. NW SE Section 18-35-1e, is spudding. Merridan Gas Co. made location for No. 2 Hamilton, SE cor. NE Section 18-35-1e.

Roxana Petroleum Co.'s No. 6 Riverbed, C N half Section 36-31-2e, was shot with 40 quarts in sand at 1,885-1,910 feet and made 650 bbls., Churchill Pool. No. 2 Taton, NE cor. NW NW Section 36-31-2e, topped the sand at 1,861 feet drilled to 1,892 feet and after a shot of 60 quarts the well made 600 bbls. Amerada Petroleum Corp.'s No. 1 Buffington, SE cor. SW NW Section 14-32-2e, is dry and abandoned at 3,574 feet.

Sulphur Compounds in Mineral Oils

Review of Past Discoveries Given as Basis for Further Research to Determine All Reactions

By P. Borgstrom and E. Emmet Reid

As a preparation for the study of the reactions of sulphur compounds that should be looked for in petroleum and petroleum products it was necessary to know what compounds have been found. Literature searches on this subject have been made by those in the industries but have not been made available to others. This review is published to diminish duplication of effort.

The problem of how to deal with sulphur compounds in petroleum and petroleum distillates became important in the oil industry when it expanded from the Pennsylvania Field to Ohio and Canada. In these oils sulphur compounds rendered the "burning oils" unusable and Ohio petroleum sold for 14 cents per barrel in the Chicago market as a result. The "Frasch process" was then introduced to remove these objectionable compounds. With increased demands for gasoline new oil fields were exploited in some of which the oil contained even greater amounts of sulphur. To aid the refiner, the "doctor," and hypochlorite methods were introduced. Even with the help of these the sulphur is still a problem as is shown by the frequency with which articles on the removal of sulphur appear.

What are the sulphur compounds with which we have to deal? All books on petroleum devote more or less space to sulphur and its removal. The information they give is usually indefinite when it comes down to details. It is generally agreed that sulphur is present in three forms (1) hydrogen sulphide, (2) free sulphur, (3) organic sulphur compounds. The first of these give comparatively little trouble as it is amenable to simple chemical treatment. Not so with the organic sulphur compounds. These may be of many kinds. Some are reactive and combine readily with many reagents, others are very indifferent. Hence some are readily detected and easily eliminated while others defy detection and elimination. Thus an alkyl sulphide may be heated to a comparatively high temperature with metallic sodium while a disulphide reacts readily[3].

We have made a laborious search of the literature to find what compounds have been isolated and identified. It is the purpose of this paper to give a list of the compounds that have been found with references to the original articles describing the work. Only a few of the references to free sulphur and hydrogen sulphide have been included while every reference to an organic sulphur compound has been listed.

For the sake of comparison, it has been deemed best to include some information about sulphur compounds in shale oils, tar oils and asphaltum. In many cases it is not certain whether the sulphur compounds found were in the original crude oil or were produced during distillation.

Hydrogen Sulphide

The first compound to be noted is hydrogen sulphide. Mabery[4] states that "H_2S appears to some extent at the beginning of distillation (Ohio oils) but the higher fractions are nearly free from it." Richardson and Wallace[5] pass air through crude oil to remove any dissolved hydrogen sulphide before they pass the oil through 60-mesh kaolin. In these cases is is probably present in the original oil as such while with Nawratil[7] it was found on distillation. Its production on distillation is not surprising in view of the work of Brooks and Humphrey[6 27] and therefore many examples of hydrogen sulphide in oils must be omitted. As tar oils and shale oils are produced by distillation they will not be considered for hydrogen sulphide can be produced in this process.

SULPHUR COMPOUNDS THAT HAVE BEEN IDENTIFIED IN PETROLEUM

	Petroleum	Shale Oil	Tar Oils
H_2S	4, 5, 7		
Sulphur	9, 5, 10	11	12
H_2SO_4	13		
Alkyl sulphates	14		
Sulphonic acids	15		
CS_2	17		16
Mercaptans (General)	19, 20		23
Alkyl mercaptans	21		24
Aryl mercaptans			22
Sulphides (General)			23
Alkyl sulphides	28, 31		24
Cyclic sulphides	32, 31	33	
Thiophene (General)	34, 35, 36	37	38, 39, 40, 41, 42
Thiophene		32, 58	48, 49
Methyl thiophenes		33, 58	44, 45, 46, 47
Ethyl thiophenes		33	
Butyl thiophene		37	
Propyl thiophenes		33, 37	50
Thionaphthene		33	51, 52
Thionaphthene 2-methyl			53
Diphenylene sulphide			54, 55
Penthiophene		57	

[1]United States Bureau of Mines Technical Paper No. 298; [2]Birch and Norris: Journal Chemical Society, 127, 1934 (1925); [3]Moses and Reid: J. A. C. S., 46, 776 (1926); [4]Mabery: Jour. Frank. Inst., 140, 3 (1895); [5]Richardson and Wallace: J. S. C. I., 21, 316 (1902); [6]Brooks and Humphry: Ind. and Eng. Chem., 9, 747 (1917); [7]Nawratil: Ding. polytech. Journal, 246, 425 (1882); [8]T. D. Girard and F. M. Colt: J. A. C. S., 49, 633 (1927); [9]F. C. Thiele: Chemiker Zeitung, 26 896 (1902); [10]S. F. Peckam: Proceed. Amer. Philos. Soc., 26, 108 (1897); [11]R. Tervet: Chemical News, 45, 93 (1882); [12]A. Kehlstadt: Ber. 13, 1345 (1880); [13]H. Vohl: Ding. polytech. Journal, 216, 47 see Liebig's Jahres, 1875, 1145; [14]Heusler and Dennstedt, Zeit. angew. Chem., 17, 264 (1904); [15]H. Veith: Ding. polytech. Jour., 277, 567 (1890); [16]H. L. Greville: J. S. C. I., 2, 488 (1883); [17]Hagar Liebig's Jahresbericht, 1867, 947; [18]Gurwitsch "Chemie der Erdol," page 103; [19]F. Ahrens: Centralblatt, 1906, I, 510; [20]F. M. Perkins: J. Inst. Petr. Tech., 3, 227 (1917) J. S. C. I., 36, 702 (1917); [21]Birch and Norris, J. C. S., 127, 398 (1925); [22]F. Schutz, Ber., 56, 162 (1923); [23]Schutz, Buschman & Wissebach Ber., 56, 1967 (1923); [24]Schutz: Brennstoff Chemie, 4, 84 (1923); [25]Smelkus: Mitth. Met. Pruf. Amt. Berlin-Dahlem, 6, 303 (1922); [26]F. Kayser: reported by W. C. Day, J. Frank. Inst., 140, 221 (1895); [27]Hackford: Oil Eng. Finance, 2, 381 (1922); [28]Mabery and Smith: Am. Chem. Jour., 13, 233 (1891); [29]Kast and Lagai: Ding. polytech. Journ., 284, 69 (1892); [30]Mabery: Am. Chem. Jour., 16, 83 (1894); [31]Thierry: Jour. Chem. Soc., 127, 2756 (1925); [32]Mabery and Quayle: Am. Chem. Jour., 35, 404 (1906); [33]Challenger, Haslam, Bramhall & Walkden: Jour. of Inst. Petr. Tech., 12, 106 (1926), see also Jour. Chem. Soc., 127, 162 (1925); [34]Edelenau and Filiti: Bull. soc. Chim., 23, 284 (1900); [35]Girard: Journ. Petr., 1906, No. 129; [36]Waterman and Heimal: Chem. Weekbald, 21, 374 (1924); [37]H. Scheibler: Ber., 59B 1198 (1926); 48, 1815 (1915); 49, 2595 (1926); 52, 1913 (1919); [38]V. Meyer: "Die Thiophen Gruppe" Veiweg & Sohn, Braunschweig, 1888; [39]Heusler: Ber., 25, 1672 (1892); 28, 493 (1895); [40]Charitschoft: Trudi Bakuer tech. Gesell., 1887, 272. [41]Ruhemann & Rosenthal: Z. angew. Chemie., 36, 153 (1923); [42]Liebermann: Ber., 20, 3231 (1887); [43]Friedman: Ber., 49, 1349 (1916); [44]Meyer & Kreis: Ber., 16, 1624, 2970 (1883); [45]Pfaff & Kreutzer: Z. angew. Chem., 36, 437 (1923); [46]K. E. Schulze: Ber., 18, 3852 (1885); [47]Pfaff & Brunck, Priv. Commun. to Furth & Jaenicke A. Angew. Chem., 38, 170 (1925); [48]V. Meyer, Ber., 16, 1465 (1883); [49]Frankel: Arzneimittels Syntheses, 3rd Edition 1912, 681; [50]Scheibler Ber., 48, 1815 (1915); [51]J. Boes: Apothekers Zeit., 17, 565 (1902); [52]Weissgerber & Kruber: Ber., 53B, 1551 (1920); [53]Weissgerber: Brennstoff Chem., 2, 1 (1921); [54]Boes, Apothekers Zeitung, 17, 638 (1902); [55]Kraemer & Weissgerber Ber., 34, 1662 (1901); [56]Kruber: Ber., 53B, 1566 (1920); [57]Scheibler: Ber., 48, 1825 (1925); [58]J. Dodonow & E. Soschestwenskaja Ber., 59B, 2202 (1926).

Presence of Free Sulphur

The question of free sulphur is far more interesting and important. Can sulphur be held in solution in more than one form? Girard and Colt[8] say "A sol which contained 1.6 per cent sulphur was allowed to stand in a test tube sealed with paraffin for several days, over powdered roll sulphur. At the end of the time it contained 3.3 per cent sulphur, 1.7 per cent more than it originally contained. Benzene saturated with sulphur in the same manner contained 1.8 per cent. This sol on evaporation gave amorphous sulphur. We have the interesting observation of F. C. Thiele[9] that the "sludge deposited by a sample of Texas petroleum contained 63.6 per cent amorphous sulphur and 6.8 per cent crystalline sulphur." Thus the work done in a benzene solution can be paralleled with some actual observations. Richardson and Wallace[5] found that sulphur crystallized from the clear oil, aerated to remove hydrogen sulphide and then passed through 60-mesh kaolin. Here the sulphur was present in the original oil, formed on removal of hydrogen sulphide by air. Most of the references found show that sulphur is deposited in the process of distillation[10] and one wonders if the sulphur was in the oil as free sulphur or formed by some reaction during distillation. This latter is rather questionable especially if the temperature of distillation is 200 degrees Centigrade or higher for at this temperature sulphur begins to react with hydrocarbons. Tervet[11] reports sulphur in shale naphtha and A. Kehlstadt[12] reports it on dry distillation of coal tar oils.

In 1875 Vohl[13] reports that sulphuric acid was found in commercial petroleum. The neutral alkyl esters of sulphuric acid were reported by Heusler and Dennstedt[14] and sulphonic acids by Veith[15]. These were probably introduced in the refinery operations and were reported 20 years or more ago. In modern refinery practice the sulphuric acid is removed by caustic soda so sulphonic acids and free sulphuric acid should be absent. Whether any neutral alkyl esters would be eliminated is a question.

With tar oils carbon disulphide is present but is usually eliminated by the scrubbers[16]. Hagar[17] says that he found it in burning oils but Gurwitsch[18] questions the results and wonders if other materials in the oils might not give this test.

The presence of mercaptans has long been suspected due to the odor but actual identification has been difficult. They are suspected of being present in the low boiling distillate[19] but not identified. F. M. Perkin[20] states that "mercaptans seem only to have been noticed in Baku oils." Birch and Norris[21] isolated and identified by mixed melting points with synthetic derivatives isopropyl and isobutyl mercaptans from Persian distillates. They also found very good indication of isoamyl mercaptan being present but in small quantity. From the disulphide they found ethyl mercaptan. This report is very good and well worth reading. With tar oils Schutz[22] has shown that tolyl mercaptan was present as disulphide and with his coworkers[23] mercaptans were detected with lead acetate in vacuum tars but not identified. In light oil distillates from tar he reports[24] methyl mercaptan and methyl sulphide.

There is a group of sulphur compounds whose constitution is questionable but interesting. Kayser[26], 1879, isolated a water white liquid boiling at 96 degrees for which he gives the formula $C_{12}H_{24}S$. What the formula is or whether the original deduction of his was correct is unknown. Hackford[27] states that "in Mexican and Palestine oils ceresine (m.p. 81 degrees) contains sulphur and on heating it loses H_2S when perhaps a dimercaptan becomes changed to an internal thioether." Wax from Mexican crude oil also contains sulphur as a thioether[25].

Sulphides Numerous

The sulphides that have been identified are numerous. Mabery and Smith[28] found dimethyl, diethyl, ethyl amyl, di-n-propyl, di-n-butyl, di-iso-butyl, diamyl, dihexyl sulphides in Ohio petroleum. Kast and Lagai[29] were unable to repeat this work but Mabery[30] again checked his observations and showed that sulphur compounds are present. Thierry[31] found in acid sludge from Persian petroleum distillate methyl ethyl sulphide and methyl propyl sulphide though it is not certain whether the latter is n-propyl or iso-propyl. With tar oils Schultz[24] found methyl sulphide and also a sulphide (b.p. 150-60 degrees) of the aliphatic series[52] of unknown constitution.

The sulphur compounds of the cyclic types such as tetramethylene sulphide and its homologs have been found in petroleum distillates and shale oils. Mabery and Quayle[32] give the series $(CH_2)_xS$ from Canadian distillates where X=7, 8 (two compounds) 9, 10, 11, 14, 16, 18 with indication also of 6. These were oxidized to sulphones, alkyl iodide addition compounds prepared and refractive incides taken. Thierry[31] in Persian oil distillates identified tetra and pentamethylene sulphides. Challenger and his coworkers[33] found tetramethylene sulphide in Kimmeridge shale oil.

Heterocyclic Rings

When one reviews the literature of the heterocyclic rings such as thiophene, thionaphthene, and diphenylene sulphide one is impressed with the lack of evidence of their presence in petroleum distillates. Edelenau and Filiti[34] state the possible occurrence of thiophene derivatives in Rumanian petroleum, Girard[35] states the presence of methyl and dimethyl in Russian petroleum, while Waterman and Heimal[36] could get no test for thiophene in Persian and Mexican distillates. With shale oil distillates we have the excellent work of Challenger and his coworkers[33] who definitely show the presence of thiophene, α-methyl, α

A. P. I. RESEARCH

The accompanying paper which has just been released for publication was read before the Petroleum Division of the American Chemical Society at the Richmond, Va., meeting held in April.

It presents the results of a search of the literature made in connection with an investigation on the "Reactions of a Number of Selected Organic Sulphur Compounds," which is listed as Project 28 of the American Petroleum Institute's Research program. Financial assistance in this work is being received from a research fund of the American Petroleum Institute.

This fund is being administered by the Institute with the co-operation of the Central Petroleum Committee of the National Research Council. The accompanying article is a contribution from the Chemistry Laboratory of Johns Hopkins University.

Mr. Borgstrom is an American Petroleum Institute Research fellow. Mr. Reid is a director of the American Petroleum Institute Research Project No. 28.

B-dimethyl, *a*-ethyl thiophene, and one higher homolog whose identity was not definitely proven but which seemed to be a propyl-thiophene. Scheibler[37] working with bituminous shale oils identified n-proply 3-thiophene, iso-propyl-2-thiophene and n-butyl 2-thiophene. J. Dodonow[38] dry distilling shales from the Kashpuski mines on the Volga found thiophene, 2-methyl thiophene and 2, 3 dimethyl thiophene.

The thiophene literature for coal tar is voluminous. The excellent work of Victor Meyer[28] gives the literature to 1888. Many reports [39], [40] [41] are given of the presence of thiophene and its derivatives dependent upon color tests[42] which have been shown to be unreliable when dealing with materials containing unsaturated hydrocarbons[43]. The homologs of thiophene that have been identified are *a*-methyl[44] [45] *B*-methyl[46] dimethyl[46] [47]. Thiophene itself was first reported by Meyer[48]. Ichthyol has long interested the pharmaceutical chemist and Frankel[49] suggests the presence of thiophene while Scheibler[50] shows a thiophene homolog, probably propyl, to be present in it. The work of separation such as that of Pfaff and Kreutzer[45] makes the findings more secure.

The presence of thionaphthene is well established in lignite tar oil[51] in coal tar[52] and in shale oil[53]. The work by Weisggerber and Kruber[52] is excellent and gives the methods of separation from naphthalene. Weissgerber[53] reported the isolation of 2-methyl-thionaphthene.

Diphenylenesulphide is reported a few times. Boes[54] in 1902 and Kraemer and Weissgerber[55] in 1901 report it in tar oils. Weissgerber and Kruber[52] and Kruber[56] give methods of separation and purification.

Penthiophene has been suggested by Scheibler[37] in shale oil but its presence not definitely proven.

ROCKY MOUNTAIN AREA

(Continued from Page 62)

bbls. a day, having increased production over 50 per cent since its completion two weeks ago.

The Adams Oil Co. will drill an offset to the Ogden Zachor No. 2, in Section 20-35-1, which made 150 bbls. on a 24-hour test. The Ogden people are getting ready to spud another well on the 40 acres on which No. 2 is located. The Big Six Oil Co. has announced its intention to drill two wells this summer on holdings in that vicinity.

The Minot "13" interests spudded in a seconded well on the Burwash tract in Section 15-34-1. No. 1, drilled last summer, reported encouraging showings of oil. A rig has been erected for the first test of the Northern Natural Gas Co. on the Rice farm, Section 11-35-2. This company will endeavor to develop a gas supply for the city of Great Falls.

New Montana Tests

Ralph Arnold, who, together with Charles Mau, is now drilling a number of tests on scattered structures in Montana, will put down a test well on Stellar Oil & Gas Co. acreage on the Porcupine Dome. This is one of the largest structures in the state and was originally surveyed and mapped by C. T. Lupton, who won fame by locating the Cat Creek Field. The Stellar Oil & Gas Co. has already done some development work on the structure, but has not put the field on the commercial list.

Two of the Arnold tests are scheduled for completion this week, the Pondera well and the Conrad Butte test. At last report, the Pondera well had reached a depth of 2,010 feet and the Conrad Butte well 2,145 feet. The Pondera well reports a showing of wet gas.

The Sunburst Oil & Gas Co. well, on the Bears Den structure, which reported a 16,000,000-foot gas flow from the Sunburst sand last week, has been drilled to the Ellis and reports an additional 10,000,000-foot flow from the upper lenses of that sand. It is the intention of the company to carry this well to the bottom of the Ellis, or a depth of perhaps 2,165 feet. Rock pressure in the Sunburst sand was given at 800 pounds, and in the Ellis at 1,200 pounds.

The Allen Oil Co. will resume drilling in its test well northwest of Great Falls, on what is known as the Benton Lake structure. The well reported a showing of oil in the upper sands, and has been standing for some time at 2,600 feet, presumably in the top of the Devonian formation.

The Bull Dog Oil & Gas Co. well, on Section 12-5-60, in Fallon County, which reported showings of gas and oil some weeks ago, is being prepared for a production test.

Runs From the Fields

Salt Creek	42,940
Teapot	816
Big Muddy	2,730
Grass Creek	2,550
Elk Basin	860
Greybull	15
Rock River	2,820
Rex Lake	100
Lance Creek	490
LaBarge	60
Poison Spider	730
Osage	370
Hamilton Dome	1,210
Mule Creek	1,270
Lander	60
Byron	80
Lost Soldier	3,340
Ferris	20
Simpson Ridge	90
Montana	
Cat Creek	2,300
Lake Basin	190
Sunburst	11,200
Colorado	
Iles	475
Walden	
Florence	919
Moffat	1,717
Fort Collins	3,196
Tow Creek	886
Boulder	25
Rangeley	100
New Mexico	
Hogback	750
Rattlesnake	126
Table Mesa	218
Artesia	1,700
Total	84,347

Field Runs for Month of May

Wyoming	
Salt Creek	1,396,030
Teapot	27,850
Big Muddy	86,590
Grass Creek	76,200
Elk Basin	29,390
Greybull	465
Rock River	85,530
Rex Lake	5,620
Lance Creek	18,550
LaBarge	2,700
Poison Spider	11,850
Osage	10,910
Hamilton Dome	32,140
Mule Creek	33,370
Lander	2,140
Byron	2,060
Lost Soldier	98,530
Simpson Ridge	2,370
Ferris	1,320
Total	1,923,615
Montana	
Cat Creek	72,770
Kevin Suaburst	358,400
Lake Basin	5,890
Total	437,060
Colorado	
Florence	24,315
Moffat	61,925
Fort Collins	116,755
Boulder	775
Rangeley	3,100
Tow Creek	30,845
Walden	3,248
Iles	14,760
Total	255,723
New Mexico	
Hogback	18,350
Rattlesnake	47,340
Artesia	54,100
Table Mesa	4,850
Total	124,640
Miscellaneous	1,550
Grand total	2,742,588

TEXAS PANHANDLE

(Continued from Page 48)

feet and was drilled to 3,088 feet and the well started off making 150 bbls. of fluid, 5 per cent water. The rig has been temporarily abandoned for Fly-Blackburn's No. 3 J. F. Weatherly, Section 19, Block Y.

McIlroy Oil Co.'s No. 10 E. Cockrell, Section 4, Block B-3, D. & S. E. Survey, produced 400 bbls. initially from lime pay at 2,960-80 feet and was deepened to 3,050 feet and is flowing 1,250 bbls. Midwest Exploration Co.'s No. 2 J. A. Whittenberg (Wilson), Section 67, Block 46, was shot with 20 quarts in lime at 2,864-83 feet without results and shot the second time with 30 quarts and responded making 75 bbls. on the swab. Mudge Oil Co.'s No. 2 E. Cockrell, Section 3, Block B-3 D. & S. E. Survey, was shot with 60 quarts in lime at 2,995 to 3,060 feet without results. The same formation was shot with 90 quarts and the well made 10 bbls. of fluid, 5 per cent water.

Ten wells were completed on the Phillips Petroleum Co.'s Panhandle leases during the week. No. 11 J. A. Whittenberg (Elra), Section 3, E. Tomlinson Survey, was shot with 130 quarts in lime at 2,809-60 feet and is swabbing 100 bbls. daily. No. 9 J. A. Whittenberg (Patsburg), Section 67, Block 46, was shot with 120 quarts in lime at 2,885 to 2,929 feet and is a 50-bbl. well. No. 11 J. A. Whittenberg (Patsburg), Section 67, Block 46, was making 100 bbls. from lime at 2,861-90 feet and was shot with 80 quarts and production was doubled. No. 13 on the same lease was shot with 60 quarts at 2,842-63 feet and is making 150 bbls. No. 18 J. A. Whittenberg (Patton), M. Whitley Survey, was shot with 150 quarts in lime at 2,880 to 2,933 feet and is a 10-bbl. well.

Phillips Petroleum Co.'s No. 19 J. A. Whittenberg (Patton), M. Whitley Survey, had the pay in lime at 2,917-45 feet; was shot with 80 quarts and the well responded making 250 bbls. No. 21 J. A. Whittenberg (Patton), M. Whitley Survey, is a 35-bbl. well after a 60-quart shot at 2,900-21 feet. No. 7 J. A. Whittenberg (Tinnie), Section 71, Block 46, was shot with 50 quarts at 2,749-65 feet and is making 60 bbls. Phillips Petroleum Co.'s No. 9 J. A. Whittenberg (Tinnie), Section 71, Block 46, had the pay in lime at 2,848-77 feet and was shot with 80 quarts to make a 150-bbl. well.

Prairie Oil & Gas Co. and associates' No. 66-A Johnson Brothers, Section 22, Block Y, is a 45-bbl. well from lime at 2,980 to 3,014 feet. Same operators' No. 67-A Johnson Brothers, Section 22, Block Y, is a 45-bbl. producer from lime pay at 2,865 to 2,800 feet. Relief Oil Co.'s No. 3-A H. E. Smith, Section 11, Block Y, had the pay in lime at 2,707 to 2,808 feet and is pumping 20 bbls. Riley and associates' No. 1 E. Cockrell, Section 1, Block B-3, D. & S. E. Survey, was shot with 620 quarts at 2,900-88 feet and is swabbing 20 bbls. of fluid daily, 5 per cent water.

The rig has been temporarily abandoned for Southwestern Oil & Development Co.'s No. 6 Johnson Brothers. Sullivan Oil Co.'s No. 1 E. Cockrell, Section 2, Block Y, is swabbing 20 bbls. daily from lime pay at 2,851 to 2,988 feet. Summitt Oil Co.'s No. 4 J. A. Whittenberg was shot with 150 quarts at 2,958 to 3,024 feet and is a 30-bbl. well. Sunburst Oil Co.'s No. 3 H. E. Smith, Section 14, Block Y, was shot with 140 quarts at 2,975 to 3,140 feet and is making 480 bbls. daily. Triangle Oil Co.'s No. 6 H. E. Smith, Section 5, Block Y, was shot with 30 quarts in lime pay at 2,700-29 feet and is producing 100 bbls. daily.

Gray County

Gray County's single completion was in the Wilcox-Pampa Pool and was Wilcox-Pampa Oil Co.'s No. 27 Worley & Reynolds, Section 62, Block 3, which was completed in granite wash at 2,930-91 feet swabbing 125 bbls. daily.

Carson County

Roxana Petroleum Corp.'s No. 3 C. R. Garner, Section 160, Block 4, in the Roxana Pool, was the best completion in Carson during the week. The well is being agitated and is flowing 560 bbls. daily from lime and granite wash at 3,095 to 3,136 feet after a 140-quart shot. In the same pool McMan Oil & Gas Co.'s No. 8 E. F. Bryan, Section 92, Block 4, is swabbing 170 bbls. daily from lime and granite wash at 3,140 to 3,200 feet. Another Roxana Pool completion is Marston Oil Co.'s No. 2 E. F. Bryan, Section 92, Block 4, which had an initial production of 120 bbls. from lime and granite wash at 3,185 to 3,205 feet. American Refining Co.'s No. 6 Burnett estate topped the pay at 3,100 feet, bottomed at 3,108 feet and is swabbing and flowing 300 bbls. daily.

Production Declines Sharply

Production in the Panhandle Field declined sharply during the week and showed a daily average loss of 7,700 bbls. The principal decline was Hutchinson County and was traced to a general decline among a number of small wells. Dixon Creek properties declined when produced naturally because of inadequate pipe line facilities. Some wells were without pipe line connections due to the Plains Pipe Line Co. discontinuing running oil until market conditions were improved.

May pipe line reports revealed that available steel storage was not being filled as rapidly as was expected and that tank car shipments are increasing. At the end of May there was 4,856,000 bbls. of available steel storage and 18,338,000 bbls. of Panhandle crude in storage as follows:

	Bbls.
Bartex Pipe Line Co.	3,117,000
Gulf Pipe Line Co.	3,254,000
Humble Pipe Line Co.	768,000
Magnolia Pipe Line Co.	3,342,000
Marland Oil Co.	2,147,000
Prairie Pipe Line Co.	636,000
Skelly Oil Co.	1,005,000
Miscellaneous companies	1,402,000
Total stocks	18,338,000

Total pipe line company receipts during May amounted to 4,206,820 bbls. and deliveries totaled 2,764,230 bbls. More than 1,386,000 bbls. went to storage and 56,420 bbls. of the pipe line receipts came from field storage.

On an average of 47,653 bbls. of oil was pumped through the Panhandle's three trunk line systems and 3,905 tank cars of oil were shipped out. Tank car shipments totaled 1,268,945 bbls.

Pipe line runs are as follows:

	Daily av.	Total
Gulf-Magnolia	17,536	543,625
Humble Pipe Line Co.	26,606	842,802
Prairie Pipe Line Co.	3,511	108,858
	47,653	1,495,285

The total steel storage capacity of Panhandle is 23,195,000 bbls. Two 55,000-bbl. tanks are being built by the McIlroy Oil Co. in S half, Section 4, Block 3-B, D. & S. E. Survey, Hutchinson County.

Another wildcat attracting attention in the Panhandle last week was Deep Rock Oil Co.'s No. 1 Lyman & Balfour, Section 9, Block 2. The well had a slight showing of oil and gas above the big lime. The showing was encountered at 2,560 feet and the test is being drilled ahead at 2,580 feet.

H. N. LAWLER RESIGNS

Howard N. Lawler, for five years head of the Skelly Oil Co.'s land department, has resigned and will be associated with Glen Smith and John D. Dwyer, independent oil producers of Tulsa, Okla.

Mr. Lawler has been engaged in the petroleum industry for over 20 years, and his experience has included many years' service with the interests of the late Theodore N. Barnsdall, and a long time with The Texas Company in this country and in Mexico. He was one of the first Texaco employes in old Mexico, and remained there until political disturbances resulted in an unsettled condition.

Returning to the United States, he became an official of the old Cosden Oil & Gas Co., later the Mid-Continent Petroleum Corp., resigning that position to head the Skelly land department.

ELECTRIFICATION OF WEST TEXAS FIELDS

SAN ANGELO, Tex., June 11.—The electrification of west Texas advanced another step Tuesday when the West Texas Utilities Co. turned on the current through its transmission line from San Angelo to McCamey, largest town in the Upton County oil field. At the same time a crew was moved from Upton to Reagan County to begin the construction of a 40-mile line from Big Lake through the Crockett County oil field to Ozona, the county seat.

The utility company's super-power station here, which will furnish current for the lines, and with a similar station at Abilene will supply 1,000 miles of lines serving 75 to 80 west Texas cities and towns, will be complete by July 15. It is costing $1,250,000 and 300 men have been engaged in its construction.

TOO LATE TO CLASSIFY

FOR SALE

Beautiful 10-room residence, thoroughly equipped, in the most exclusive section of Tulsa. Built and for sale by owner. Sold at sacrifice—wonderful opportunity for business man seeking ideal home. Call telephone 3-3433 or address 1006 17th place, Tulsa, Okla.

REFINING AND MARKETING

Unusual Situation Develops in West Coast Tanker Rates

Recent fixtures for the intercoastal trade bring to light a rather interesting situation in the California tanker market and one which is hardly believable. Two dirty boats were chartered a short time ago for North of Hatteras at $1.01 and $1.03 respectively. A clean boat brought 90 cents a short time previous for a similar movement. All three fixtures call for June loading and at these rates dirty boats are commanding a premium over white tankers. A new case-goods record was established for Los Angeles Harbor during the month of May when the United States Shipping Board liner, West Prospect, sailed for the Orient with 158,400 cases of gasoline and kerosene.

A total of 445,520 ten-gallon cases of gasoline and kerosene left Los Angeles Harbor during that month destined for the Antipodes and the Orient. It is estimated that better than 20 000 000 gallons of gasoline, kerosene and other refined products will move out of Los Angeles Harbor in the case-oil export trade during the next three months. The movement of refined oils to the Orient discloses the fact that oil companies operating in China are storing refined products at coast ports instead of inland as heretofore on account of the unsettled conditions prevailing in that country.

The Standard Transportation Co.'s tanker Yankee Arrow returned to Los Angeles Harbor several days ago after discharging her last cargo of kerosene at Shanghai. Before leaving the latter point it was decided to remove some of the company's stocks held inland to a more strategic point and this tanker was accordingly dispatched a distance of approximately 750 miles up the Yangtse River where she loaded a part of the stocks on hand and moved them down stream to Shanghai. Before proceeding to Chin Lin Kee, 150 miles beyond Hankow, to bring the last storage of kerosene down stream for safe keeping, the entire superstructure of the tanker was enclosed with steel plates. The vessel was fired on several times en route but according to Capt. Ingomar (Paintbrush) Anderson, nothing happened due to the fact that she was convoyed by an American destroyer.

The Standard's stock of gasoline and kerosene is being moved from interior stations as a precautionary measure and also because of the fact that there is no accepted money in the region with which oil can be purchased. Both the Northern and Southern governmental heads have issued paper money which is declared to be worthless. Mexican silver dollars, the standard for coin in China, have disappeared from the war zone and reports indicate that the worthless paper which is in evidence everywhere is being put into circulation at the point of a bayonet. The Yankee Arrow, which is now in the Bethlehem yards for cleaning and painting, will make a coastwise voyage to Seattle in the near future. The Chinese crew in the meantime is being transferred to other vessels plying from this port with Orientals.

New Tankers

The Krupps of Kiel, Germany, have recently been given a contract to build a 15,600-ton Diesel tanker for the Standard Oil Co. of California and delivery is anticipated early next year. The Standard of California is also preparing specifications for the conversion of the former Shipping Board tanker District of Columbia to Diesel propulsion and bids will be requested in the near future.

The tanker Tuxpanoil, another familiar vessel in Los Angeles Harbor, is also scheduled to be converted to Diesel propulsion and the job will be undertaken by Bethlehem at Sparrows Point. This boat was recently purchased from the Shipping Board by the Oil Transport Co. of Maryland for $166,000. The conversion job, which will result in her being the first geared Diesel-engined vessel afloat, will cost $185,000 and require 110 days to complete.

State Aids in Trying Out New Process of Making Carbon Black

SHREVEPORT, La., June 13.—A conditional permit has been issued by the State Department of Conservation to the New Process Carbon Black Co. of Monroe, La., to manufacture carbon black under the Barbour method. The plant of the New Process Carbon Black Co. will be permitted to use natural gas for 60 days, and if in that period the yield of carbon black meets claims of the inventors of the process a permanent permit will be issued, according to W. F. Chisholm, director of the minerals divisions of the Department of Conservation at Shreveport.

GOOD ROADS REDUCE GASOLINE CONSUMPTION

Average gasoline consumption was reduced from 521 to 454 gallons per car per year as a result of highway paving done in North Carolina in the year from July, 1922, to July, 1923, according to B. C. Frost, as quoted in a statement made at a recent meeting of the Northern California section of the Society of Automotive Engineers in San Francisco. This reduction per year amounts to a saving of $16.75 per car with gasoline selling at 25 cents a gallon.

Records of an automobile dealer in Illinois who operates a drive-yourself service and separates his cars so that some were operated almost wholly on concrete roads or hard surface pavements and others on country roads, showed, according to a statement by A. J. Eddy, a civil engineer of Berkeley, Calif., that the automobile owner saves an average of 2.4 cents a mile on the hard surface highway. The speaker also referred to an estimate made by Col. H. C. Boynton, formerly conected with the Portland Cement Association, that an owner would save 2.6 cents a mile by driving on concrete or other hard surface roads rather than on dirt roads.

Taking the mean of these estimates and assuming that the owner saves 2½ cents a mile and drives 5,000 miles per year, his saving would exceed $125 a year. Although no data were available on motor trucks, the saving may amount to as much as 5 cents a mile.

WYOMING INSPECTION

CASPER, Wyo., June 11.—The Wyoming inspectors of the State Food and Oil Division have been examining gasoline filling station pumps and refinery outputs the past few weeks. One result has been the condemnation of some 30 gasoline pumps at various filling stations that were either giving under or over measure. Also one refinery that has placed a by-product on the market labelled "Rubbing Alcohol," has been ordered to sell this product under some other name as it does not contain alcohol. Two refiners were found to be producing gasoline under the navy standard as specified by the Wyoming laws and were ordered to bring their gasoline up to this standard or charges will be filed against them.

Interstate Commerce Commission Postpones New Railroad Rates

The date on which new rates will become effective from Mid-Continent refining centers to destination points in Western Trunk Line territory was again postponed in an order issued by the Interstate Commerce Commission at Washington, D. C. on June 7. The latest modification in the new rates follows the hearing held at Washington before the Interstate Commerce Commission the first three days of the month. At this hearing Oklahoma refiners and other interested parties including the defendant carriers were permitted to present additional testimony with further arguments.

The order of June 7, which refers to Dockets 15.584, 15,585, 16,065 and 16,066, was as follows:

"That the order entered in the above titled proceedings on January 14, 1927, and which as modified is to become effective June 20, 1927, be and it is hereby further modified so that it will become effective on August 20, 1927, in so far as it requires the establishment of the rates therein prescribed to St. Louis, Mo., and destinations east of the Mississippi River to which the short routes from Tulsa, Okla., make through Mississippi River crossings, Davenport, Iowa, and south.

"That said order of January 14, 1927, be and it is hereby modified so that it will become effective on July 20, 1927, insofar as it requires the establishment of rates other than those described in the next preceding paragraph hereof.

"And it is further ordered that defendandants or other participating carriers be and they are hereby authorized to further postpone until August 20, 1927, or July 20, 1927, as the case may be on not less than three days' notice to this Commission and to the general public, the effective date of all schedules which have been filed in compliance with said order of January 14, 1927, without regard to the provisions of Rule 9 of Tariff Circular 18-A."

The postponement, especially as it applies to rates through St. Louis and points east, is considered a partial victory for the intervenors and defendants in the case. In the presentation of new testimony at the Washington hearing Oklahoma refiners stressed the alleged unfairness of the new rates as they applied to eastern points through St. Louis. It was contended that the Northeast Oklahoma refiners were entitled to the same rates as the Kansas refiners based on comparative mileage from the two groups to the St. Louis gateway. It is assumed that the postponement to August 20 is made in order to give the Commission time to further consider the issues raised at the Washington hearing.

INCREASES FUEL OIL STORAGE

CHICAGO, June 11.—The Commerce Petroleum Co. announces that it has secured the tankage formerly used by Armour & Co., for the storage of animal oil. The equipment consists of seven large tanks with a capacity of about 400,000 bbls. and is located on the Chicago Junction R. R. close in to the Stock Yards. The company will confine its business to the industrial fuels and not handle domestic fuel oils the coming season, according to present plans.

OIL PLANT PURCHASED

CHATHAM, Ontario, June 11.—David D. Gibson of Lethbridge has bought the Calgary plant of the Beaver Oil Refining Co. with distributing stations at Vulcan and Stettler.

USE ROWSEY PROCESS AT TEXARILLO PLANT

The Rowsey process will be used at the new refinery which the Texarillo Refining Co. is to build at Amarillo, Tex. according to Dorset Carter, president of the Pantex Pipe Line Co. The Rowsey process was developed by G. I. Rowsey of Amarillo and is now in operation at the Amarillo refinery of the Amarillo Refining Co.

Mr. Rowsey was the pioneer operator in the handling of Panhandle crude. The refining of the crude has presented several peculiar operating problems which operators have found difficult to solve. The Rowsey process covers the skimming and cracking of the crude with pipe stills and also the chemical treatment of the finished products.

It is expected that the new refinery will be built on land adjoining the refinery of the Amarillo Refining Co. Reece S. Allen, president of the Amarillo Refining Co. is also interested in the new company.

PETROLEUM EXCHANGE NEW CHICAGO COMPANY

CHICAGO, June 11.—The Petroleum Exchange has been incorporated for $100,000, with offices at 624 South Michigan Avenue. The incorporators are A. G. Talbot, C. M. Brennan and E. Burke. The purposes are stated to be to mine for, manufacture and deal in petroleum and its products. The organizers are the present officers of the Advance Petroleum Co., and they state they have no intention of conducting an exchange but will transact a business of the nature indicated by the powers under the charter. Details will be supplied later. The present offices of the company are in the Consumers Building at the corner of Quincy and State Streets.

The officers of the Petroleum Exchange, Inc., are A. L. Talbot, president and treasurer; C. M. Brennan and R. D. Brennan, vice presidents. The former is the sales manager of the Advance Petroleum Co. and the latter secretary of the James B. Berry & Sons Co. The Advance Petroleum Co. will be continued with charge of the production interests of Messrs. Talbot and Sackett, who will retain their present offices with that organization. It is planned for the new company to do a marketing business on a large scale with ample capital and important refinery connections which will be announced later. The new organization will begin business on July 1.

RECEIVES DEGREE OF LLD.

CHICAGO, June 11.—Col. Robert W. Stewart, chairman of the board, Standard Oil Co. of Indiana, has been honored with the degree of Doctor of Laws by Coe College at Cedar Rapids, Iowa. Colonel Stewart graduated from Coe College with the class of 1886, and proceeded to Yale University where he entered the law school receiving the degree of LLB. The exercises in connection with the conferring of the degree were held at Cedar Rapids, his home town.

EL SEGUNDO MANAGER

A. S. Russell, who has been chief engineer of the manufacturing department of the Standard Oil Co. at Richmond, Calif., has been appointed manager of the company's plant at El Segundo, succeeding Luther D. Dimm, who has just retired after 37 years' service.

Brief Items for Plant Operators

Derive Charts With Which to Determine Radiation of Gases

Of the recent contributions from the department of Fuel and Gas Engineering of the Massachusetts Institute of Technology, a paper by Hoyt C. Hottel on "Radiation From Gases," which is to be presented in the near future before the American Institute of Chemical Engineers is among the most important. In the past, it has been customary to neglect radiation from gases in problems of heat transmission, due to the complexity of the computations involved. Hottel, however, has derived a number of charts which make it possible to calculate this radiation without difficulty. He has shown by a number of practical examples that this factor is far from negligible and in fact in many cases is even greater than the transfer of heat by convection.

His charts will be of great assistance in the design of furnaces at refineries involving heat transfer from gases. It has been known, for example, that the heat transfer coefficients actually found in the convection tubes of cracking coils were larger than those calculated from the usual convection formulas, and it was therefore impossible to compute with any degree of accuracy the number of tubes required. By combining Hottel's charts and the convection formulas, values are obtained for the coefficients which agree closely with those actually found in practice.

The original investigations of the Department of Fuel and Gas Engineering are made both in the laboratory and on fuel scale apparatus in the field. Research is now being carried out in the laboratory on rates of flame propagation in gaseous mixtures, hydrogenation of coal, synthesis of hydrocarbons, reactions in gas producers and water gas generators, and on a number of other subjects.

In the various field stations one of which is located at the refinery of the Tide Water Oil Co., studies of a number of plant operations are being made. These include such subjects as heat transfer in regenerators, steam decomposition in water gas generators and efficiency and operating characteristics of crude petroleum stills.

REPORT ON CRACKING OF WAINWRIGHT CRUDE

By Victor Lauriston

CHATHAM, Ontario, June 11.—A report of the Universal Oil Products Co. of Chicago, owners of the Dubbs cracking process, on the application of the process to the heavy Wainwright crudes has been made public by the Scientific and Research Council for Alberta. The gist of the report is as follows:

"The present cost of refining the cracked distillates will be between 25 and 30 cents per barrel of gasoline product. The cost of refining depends mainly upon marketing conditions, e.g., the question of meeting specifications such as water white color, doctor sweet and negative corrosion gasoline. When these specifications are not rigid it may be reduced, but this cost is upon a product meeting all these specifications. This figure does not include the cracking of the charging stock which will be in the neighborhood of 50 cents per barrel.

"The question of water and mineral matter in the oil will not affect the commercial cracking of same to any extent which would prevent consideration of cracking. In the event that it is too costly or too difficult to remove the water and mineral matter by pretreatment, a heat exchanger may be used in conjunction with the cracking unit. Further than this the question resolves itself to design of the cracking plant so as to obtain the velocity required to prevent settling of the mineral matter in the tubes. The question of the removal of water is one that has been definitely settled upon a commercial scale, and the Dubbs process is today handling charging stocks direct containing several per cent of water together with mineral matter, such as salts of the various kinds present in the Wainwright crude.

"Regarding the nature and value of the residues: where a coke is the only residue it may be used for fuel purposes, being very high in quality in that respect. The coke formed from the cracking of these oils has a very high calorific value, being between 15 and 16 B.t.u.'s per pound. The ash in the coke from the cracking of Wainwright crude will depend upon the extent to which the salt water has been removed before cracking, but under any circumstances this coke will be highly superior to coal as a fuel. As the mineral matter in the bitumen is variable, the ash in the coke will vary likewise. In the event that the operation is of the liquid residue type, a liquid fuel of any desired characteristics may be produced. Coke will also be a product of this type of operations."

STABILIZER ARGUMENT SET FOR OCTOBER 24

By L. M. Fanning

NEW YORK, June 11.—The trial of the suit for alleged infringements of so-called stabilizer patents brought by the Carbide & Carbon Chemicals Corp. against the Phillips Petroleum Co. was completed before Judge Hugh M. Morris in the Federal Court at Wilmington Friday. Final argument was set for October 24. The final days of the trial were taken up mainly by the completion of the testimony of Dr. George O. Curme, Jr., chief chemist, and Mr. Cornwell, superintendent of the Carbide & Carbon Chemicals Corp., and by the expert testimony of Dr. A. B. Lamb of Harvard University for the plaintiff. For the defense, Dr. Warren K. Lewis of the Massachusetts Institute of Technology completed his testimony and other witnesses gave technical testimony on the analysis of the products made by the processes.

The suit is of particular importance for it involves the use of apparatus at many of the natural gasoline plants and the outcome will indicate whether the natural gasoline manufacturers will continue to pay royalties to the Carbide & Carbon Chemicals Corp.

The first testimony of the suit was given June 1. In addition to the suit against the Phillips Petroleum Co. testimony has been taken in a similar suit pending against The Texas Company.

The plaintiffs claim they own the stabilizer patents and through the use of them the natural gasoline industry was able to increase the gasoline yields and also manufacture a more stable product. The defense is attempting to establish the fact that this process was in prior use and that its adoption in the natural gasoline industry was an outgrowth of its use in other industries.

FUEL CHARACTERISTICS

The Department of Engineering Research of the University of Michigan has published Dr. G. G. Brown's work on the relation of fuel characteristics to engine performance in booklet form and these are available from the University of Michigan at Ann Arbor for $1. The booklet is a summary of all work done in connection with the research program of the Association of Natural Gasoline Manufacturers and includes the basis of Doctor Brown's speech before the association's annual meeting on May 25.

AMONG THE TECHNICAL MEN

J. C. Hinds, superintendent of the Electra, Tex., refinery of the Waggoner Refining Co., obtained all his experience in the art of petroleum refining during the past nine years. His training has been of practical nature, covering all phases of operation in connection with the skimming and cracking of petroleum products from crude oil.

J. C. Hinds

His first experience was obtained at the Augusta, Kans., refinery of the White Eagle Oil & Refining Co. in 1918 and 1919. He was employed as stillman's helper and stillman at that plant. During a part of 1919 he was a stillman at the Wichita Falls, Tex., refinery of the Texhoma Oil & Refining Co., now known as the Continental Oil Co.

He left this plant to become a stillman and treater at the Iowa Park plant of the Walker Consolidated Petroleum Co. This plant was later shut down and dismantled. Starting in 1921, Mr. Hinds was connected with the Burktex Refining Co. at Burkburnett. He was employed in the plant laboratory for a time and later was superintendent.

During a part of 1924 he operated the Burton pressure stills at the El Dorado, Ark., refinery of the Lion Oil Refining Co. After being connected with the Rock Island Refining Co. at Duncan, Okla., for a short time he accepted his present position with the Waggoner Refining Co. in September, 1924. The refinery is a skimming plant with a rated capacity of 3,500 bbls. daily.

FIELDNER APPOINTED EXPERIMENT ENGINEER

Arno C. Fieldner, superintendent of the Pittsburgh experiment station of the United States Bureau of Mines, has been appointed chief engineer, division of experiment stations of the bureau, effective July 1. In his new position, Mr. Fieldner will correlate the scientific activities of the bureau's experiment stations at Pittsburgh, Pa.; Salt Lake City, Utah; Reno, Nev.; Berkeley, Calif.; Tucson, Ariz.; Seattle, Wash.; Bartlesville, Okla.; Rolla, Mo.; Minneapolis, Minn.; Birmingham, Ala.; and New Brunswick, N. J. At these stations problems dealing with the elimination of waste in the mineral industries are being studied.

Mr. Fieldner, who has served as superintendent of the Pittsburgh experiment station for six years, is rated as one of the bureau's outstanding research specialists. He is regarded as an authority on the technology of coal, coke and gas, and ventilation problems, involving noxious gases, in mines, tunnels and elsewhere.

Mr. Fieldner, a native of Ohio, was born December 12, 1881, graduated in chemical engineering at Ohio State University in 1906 and in 1907 joined the staff of the United States Geological Survey and with that organization and later with the Bureau of Mines engaged in research, performing notable work in connection with the utilization of coal, coke, petroleum and other fuels.

During the war Mr. Fieldner served as a major in the Chemical Warfare Service, in charge of gas mask research. The methods developed by him for testing the efficiency of gas masks and absorbents were generally used by the Chemical Warfare Service and were later adopted by some of the laboratories of the Allies.

While serving as superintendent of the Pittsburgh experiment station of the Bureau of Mines, Mr. Fieldner's interests widened from fuels and gas to research on safety in mines, metallurgical and industrial establishments, and health problems in the mining and allied industries. He organized and directed the exhaustive research work of the Bureau of Mines in co-operation with the New York and New Jersey Tunnel Commission on the combustion of automotive exhaust gases and the minimum safe concentration of carbon monoxide in tunnel atmospheres. The professional degree of chemical engineer was conferred on him in 1923 by Ohio State University in recognition of this work.

In 1924, Mr. Fieldner spent six months in visiting European laboratories and industries, studying especially the carbonization and processing of coal, and safety in mines research.

Mr. Fieldner has, for a number of years, been chairman of the committee on coal and coke of the American Society for Testing Materials, has twice been chairman of the chemical committee of the American Gas Association, and is a continuing member of the managing committee of the technical section of this organization. He has served as chairman of the gas and fuel section of the American Chemical Society and is now a member of the executive committee. He likewise is a member of the committee on coal and coke of the American Institute of Mining and Metallurgical Engineers, is a past chairman of the steel works section of the Engineers Society of Western Pennsylvania, and is an active member of the Coal Mining Institute of America.

Mr. Fieldner has contributed a large number of articles to the scientific and technical press and is the author of a long list of bulletins and other publications of the Bureau of Mines. Two years ago he was invited to become a member of the Coal Research Club of England.

REFINERY AND CRUDE PRICES

Quotations on Principal Refined Products and Crude Petroleum Markets in All the American Oil Fields

GASOLINE AND NAPHTHA

	June 14		June 7		May 31	
OKLAHOMA (Group 3)—						
50-42 450 endpoint (Naphtha)	.06¼	.06⅜	.06⅜	.06½	.06½	
56-58 450 endpoint	.06¼	.06⅜	.06⅜	.06½	.06¼	
58-60 450 endpoint	.06⅜	.06½	.06⅜	.06½	.06¼	.06½
58-60 437 endpoint (U. S. Motor)	.06⅜	.06¾	.06⅝	.06¾	.06½	.06¾
60-62 400 endpoint	.07		.07		.07	.07¼
64-66 375 endpoint	.07⅛	.07¼	.07¼		.07¼	
68-70 360 endpoint	.07½		.07½	.07¾	.07½	.07¾
64-66 437 endpoint	.06½		.06½		.06½	
KANSAS—						
58-60 437 endpoint (U. S. Motor)	.06¾	.07	.07		.06¾	.07
NORTH TEXAS—						
58-60 450 endpoint	.06¼		.06⅜	.06⅝	.06⅜	.06⅝
56-58 437 end point	.06¼	.06½	.06¼	.06½	.06¼	.06½
58-60 437 endpoint (U. S. Motor)	.06½	.06⅝	.06½	.06⅝	.06½	.06⅝
60-62 400 endpoint	.06¾		.06¾	.07	.06¾	.07
64-66 390 endpoint	.07		.07		.07	
64-66 375 endpoint	.07	.07¼	.07	.07¼	.07	.07¼
68-70 360 endpoint	.07½		.07½		.07½	
64-66 437 endpoint (blend)	.06½		.06½		.06¼	.06½
NORTH LOUISIANA—						
56-58 437 endpoint (U. S. Motor)	.06¾		.06¾	.07	.06¾	
ARKANSAS—						
58-60 437 endpoint (U. S. Motor)	.07		.07		.06¾	
PENNSYLVANIA—						
52-54 Naphtha	.07¾	.08½	.07¾	.08½	.07¾	.08½
54-56 Naphtha	.08½	.08¾	.08½	.08¾	.08¼	.08½
58-60 Gasoline	.09	.09¼	.09	.09¼	.08½	.08¾
60 Gasoline	.09¼	.09½	.09¼	.09½	.09¼	.09½
62 Gasoline	.10	.10¼	.10	.10¼	.10	.10¼
64 Gasoline	.10¼	.10½	.10¼	.10½	.10¼	.10½
CALIFORNIA—						
58-60 437 endpoint (U. S. Motor) domestic	.07½	.08½	.07½	.08½	.09	.10½
CHICAGO DISTRICT (Based on Group 3)—						
50-52 450 endpoint (Naphtha)	.06½		.06¼	.06½	.06¼	
56-58 450 endpoint	.06⅜	.06½	.06¼	.06⅜	.06¼	.06⅜
58-60 437 endpoint (U. S. Motor)	.06¾		.06¾		.06½	.06¾
60-62 400 endpoint	.07		.07	.07⅛	.06¾	.07
64-66 375 endpoint	.07¼		.07¼		.07	.07¼
68-70 360 endpoint	.07½	.07¾	.07½	.07¾	.07½	
64-66 437 endpoint (blend)	.06½		.06½		.06½	

NATURAL GASOLINE

	June 14		June 7		May 31	
OKLAHOMA (Group 3)—						
Grade AA, 80-87.9, 375 e.p., rec. 90%	.05	.05⅛	.05½		.06	
Grade A, 72-79.9, 375 e.p., rec. 90%	.05	.05⅛	.05½		.06	
Grade BB, 84-92, 375 e.p., rec. 85%	.05		.05¼		.05½	
Grade B, 76-83.9, 375 e.p., rec. 85%	.05		.05¼		.05½	
Grade C, 80-90, 375 e.p., rec. 78%	.05		.05	.05¼	.05¼	.05½
NORTH TEXAS—						
Grade AA, 80-87.9, 375 e.p., rec. 90%	.05		.05¼	.05½	.05¾	.06
Grade A, 72-79.9, 375 e.p., rec. 90%	.05		.05¼	.05½	.05¾	.06
Grade BB, 84-92, 375 e.p., rec. 85%	.04¾	.05	.05	.05¼	.05¼	.05½
Grade B, 76-83.9, 375 e.p., rec. 85%	.04¾	.05	.05	.05¼	.05¼	.05½
Grade C, 80-90, 375 e.p., rec. 78%	.04¾	.05	.05		.05¼	
NORTH LOUISIANA—						
Grade AA, 80-87.9, 375 e.p., rec. 90%	.05	.05¼	.05½	.05¾	.06	
Grade BB, 84-92, 375 e.p., rec. 85%	.05	.05¼	.05¼	.05½	.06	
Grade C, 80-90, 375 e.p., rec. 78%	.04¾		.05		.05	.05¼
CALIFORNIA—						
75-85, 370, 390 endpoint	.09	.10	.09	.10	.09	.10
CHICAGO DISTRICT (Based on Group 3)—						
Grade AA, 80-87.9, 375 e.p., rec. 90%	.05⅛		.05½		.06	
Grade A, 72-79.9, 375 e.p., rec. 90%	.05⅛		.05½		.06	
Grade BB, 84-92, 375 e.p., rec. 85%	.05	.05¼	.05¼		.05½	.05¾
Grade B, 76-83.9, 375 e.p., rec. 85%	.05	.05⅛	.05¼		.05½	.05¾
Grade C, 80-90, 375 e.p., rec. 78%	.05		.05	.05¼	.05¼	.05½

BURNING OIL

	June 14		June 7		May 31	
KANSAS—						
41-43 water white Kerosene	.04½		.04½	.04¾	.04¾	.05
OKLAHOMA (Group 3)—						
41-43 water white Kerosene	.04¼	.04¼	.04¼	.04¼	.04⅜	.04½
42-44 water white Kerosene	.04½		.04⅝	.04¾	.04¾	
NORTH LOUISIANA—						
41-43 prime white Kerosene	.04⅝	.04¾	.04¾		.04¾	
42-43 water white Kerosene	.05		.05	.05¼	.05	.05¼
NORTH TEXAS—						
41-43 water white Kerosene	.04	.04⅛	.04¼		.04⅜	.04½
40-42 water white Kerosene	.03¾	.04	.03⅞	.04	.03¾	.04
ARKANSAS—						
41-43 water white Kerosene	.04½	.04¾	.04⅝	.04¾	.04⅝	.04¾
PENNSYLVANIA—						
43 Kerosene prime white	.06¼	.06½	.06¼	.06½	.06¼	.06½
45 Kerosene water white	.06¼	.06½	.06⅜	.06⅝	.06⅜	.06⅝
46 Kerosene water white	.06¾	.07	.06⅞	.07⅛	.06⅞	.07⅛
47 Kerosene water white	.07	.07¼	.07	.07¼	.07	.07¼
300 Mineral Seal	.07¾	.08	.07¾	.08	.07¾	.08
CALIFORNIA—						
38-40 water white (high burning test)	.05¾	.06½	.05¾	.06½	.05¾	.06½
Engine distillate, 43-45 445 endpoint	.07	.07½	.07	.07½	.07	.07½
Engine distillate, 42-44 480 endpoint	.06¾	.07	.06¾	.07	.06¾	.07
CHICAGO DISTRICT (Based on Group 3)—						
41-43 water white Kerosene	.04¾	.04½	.04¾	.04½	.04¾	.04½
42-44 water white Kerosene	.04⅝	.04¾	.04⅝	.04¾	.04¾	.05

FUEL OILS

	June 14		June 7		May 31	
KANSAS—						
24-26 Fuel Oil	1.00	1.05	1.00	1.05	1.00	1.05
32-36 Gas Oil	.02¾	.03	.02¾	.03	.02¾	.03
38-40 Distillate	.03½		.03½		.03½	
OKLAHOMA (Group 3)—						
Below 18 Fuel Oil	.85	.87½	.85	.87½	.85	.87½
18-22 Fuel Oil	.87½	.90	.87½	.90	.87½	.90
22-26 Fuel Oil	.90	.92½	.90	.92½	.90	.92½
24-26 Fuel Oil	.90	.95	.90	.95	.92½	.95
26-30 Fuel Oil	.95	.97½	.95	.97½	.97½	1.00
28-30 Fuel Oil	1.00	1.05	1.00	1.05	1.00	1.05
32-36 Gas Oil (dark)	.02⅝		.02⅝		.02¾	
32-36 Gas Oil (straw overhead)	.02⅝	.02¾	.02⅝	.02¾	.02¾	.02⅞
36-38 Distillate	.03⅛		.03⅛	.03¼	.03¼	.03¼
38-40 Straw Distillate	.03⅛	.03¼	.03¼	.03½	.03¼	.03½
NORTH TEXAS—						
24-26 Fuel Oil (sellers' cars)	.85		.85	.90	.87½	.92½
32-36 Gas Oil (straw)	.02½	.02¾	.02⅝	.02¾	.02⅝	.02¾
38-40 Straw Distillate	.03		.03	.03¼	.03	.03¼
NORTH LOUISIANA—						
18-20 Fuel Oil	1.10	1.15	1.10	1.15	1.10	1.15
32-36 Gas Oil	.03¼	.03½	.03	.03¼	.03	.03¼
ARKANSAS—						
36-38 Distillate	.03½	.03¾	.03½	.03¾	.03½	.03¾
32-36 Gas Oil (straw)	.03¼	.03½	.02¾	.03	.02¾	.03
16-20 Refinery Fuel Oil	1.00	1.05	1.00	1.05	1.00	1.05
GULF COAST (South Texas)—						
Gas Oil	.04¼	.04⅜	.04¼	.04⅜	.04¼	.04⅜
Fuel Oil	1.50	1.60	1.50	1.60	1.50	1.60
PENNSYLVANIA—						
30-34 Fuel Oil	.04¼	.04¾	.04¼	.04¾	.04½	.05
36-40 Fuel Oil	.04¾	.05	.04¾	.05	.04¾	.05
CALIFORNIA—						
33-36 Distillate	.03¾	.04	.03¾	.04	.03¾	.04
27-32 Distillate	.03¼	.03¾	.03¼	.03¾	.03¼	.03¾
*15-20 Fuel Oil, Bunkers (at tide water)	.85	1.00	.85	1.00	.85	1.00
15-20 Fuel Oil (cargo lots)	.71	.75	.71	.75	.71	.75
27 plus Diesel	1.15	1.19	1.15	1.19	1.15	1.19
CHICAGO DISTRICT (Based on Group 3)—						
24-26 Fuel Oil (sellers' cars) Group 3	.92½	.95	.95	.97½	.95	
22-26 Fuel Oil (sellers' cars) Group 3	.90	.92½	.90	.92½	.90	.92½
18-22 (Group 3)	.90		.87½	.90	.85	.90
16-20 Smackover	1.10	1.15	1.10	1.15	1.12½	
32-36 Gas Oil (zero)	.02⅞	.03	.02⅞	.03	.02⅞	.03
32-36 Gas Oil (industrial)	.02¾	.02⅞	.02¾	.02⅞	.02¾	.02⅞
36-38 Distillate	.03	.03⅛	.03	.03⅛	.03	.03⅛
38-40 Straw Distillate	.03¼	.03⅜	.03¼	.03⅜	.03¼	

*Bunkers.

LUBRICATING OIL AND WAX

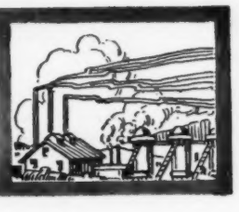
	June 14		June 7		May 31	
OKLAHOMA (Group 3)—						
100 vis., 2 color, 20-25 cold test	.06½	.06¾	.06½	.06¾	.06½	.06¾
100 vis., 3 color, 20-25 cold test	.06¼	.06½	.06¼	.06½	.06¼	.06½
150 vis., 3 color, 20-25 cold test	.08½	.08¾	.08½	.08¾	.08½	.08¾
150 vis., 4 color, 20-25 cold test	.08¼	.08½	.08¼	.08½	.08¼	.08½
180 vis., 3 color, 23-28 cold test	.10	.10¼	.10	.10¼	.10	.10¼
180 vis., 4 color, 23-28 cold test	.09¾	.10	.09¾	.10	.09¾	.10
180 vis., 5 color, 23-28 cold test	.09½	.10	.09½	.10	.09½	.10
200 vis., 3 color, 23-28 cold test	.10½	.11	.10½	.11	.10½	.11
200 vis., 4 color, 23-28 cold test	.10¾	.10⅞	.10¾	.10⅞	.10¾	.10⅞
200 vis., 5 color, 23-28 cold test	.10½	.10¾	.10½	.10¾	.10½	.10¾
240 vis., 3 color, 25-30 cold test	.14	.14¼	.14	.14¼	.14	.14¼
240 vis., 4 color, 25-30 cold test	.13½	.13¾	.13½	.13¾	.13½	.13¾
240 vis., 5 color, 25-30 cold test	.12½	.13	.12½	.13	.12½	.13
280 vis., 3 color, 25-30 cold test	.15¾	.16¼	.15¾	.16¼	.15¾	.16¼
280 vis., 4 color, 25-30 cold test	.15¼	.15½	.15¼	.15½	.15¼	.15½
280 vis., 5 color, 25-30 cold test	.14½	.15	.14½	.15	.14½	.15
Cylinder Stocks:						
600, steam refined, light green	.07½	.10	.07½	.10	.07½	.10
600, steam refined, dark green	.05	.06	.05	.06	.05	.06
190-200 vis. @ 210 Bright Stock	.31	.33	.31	.33	.31	.33
150-160 vis. @ 210 Bright Stock	.26		.26		.26	
Waxes:						
124-126 White Crude Scale Wax	.02⅝	.02¾	.02⅝	.02¾	.02½	.02¾
PENNSYLVANIA—						
34 Neutral	.07¼	.07½	.07¼	.07½	.07¼	.07½
34 Sundebloom Neutral	.08½	.08¾	.08½	.08¾	.08½	.08¾
36 Miners' Neutral	.07	.07¼	.07	.07¼	.07	.07¼
150, 3 color	.28¼	.28½	.28¼	.28½	.28¼	.28½
180, 3 color	.32¼	.32½	.32¼	.32½	.32¼	.32½
200, 3 color	.34¼	.34½	.34¼	.34½	.34¼	.34½
220, 3 color	.34¼	.36½	.34¼	.36½	.34¼	.36½
600, steam refined	.08¾	.09	.08¾	.09	.08¾	.09
635, steam refined	.10¾	.11	.10¾	.11	.10¾	.11
650, steam refined	.12¾	.13	.12¾	.13	.12¾	.13
600, Pennsylvania flash	.17½	.18	.17½	.18	.17½	.18
630, Pennsylvania flash	.28	.28½	.28	.28½	.28	.28½
*550, E filtered	.17¼	.18	.17¼	.18	.17¼	.18
*600, E filtered	.18¼	.19	.18¼	.18¾	.18¼	.18¾
600, E filtered	.17¼	.17¾	.17¼	.17¾	.17¼	.17¾
600, D filtered	.25	.25½	.25	.25½	.25	.25½
550, E filtered	.17½	.18	.17½	.18	.17½	.18
550, D filtered	.21½	.22	.21½	.22	.21½	.22
Pennsylvania Bright Stock	.33	.33½	.33	.33½	.33	.33½
†122-124 White Crude Scale Wax	.02⅞	.03	.02⅞	.03	.02⅝	.02¾
†124-126 White Crude Scale Wax	.03	.03⅛	.03	.03⅛	.02¾	.02⅞

*At Warren, Pa. †At New York City.

GULF COAST (South Texas)—							
No. 2	color, 100 vis., pale oil	.07	.07½	.07	.08	.07	.08
No. 3	color, 200 vis., pale oil	.10½	.11	.10½	.11½	.10½	.11½
No. 3	color, 300 vis., pale oil	.11½	.12	.11½	.12½	.11½	.12½
No. 3½	color, 500 vis., pale oil	.13½	.14	.13½	.14	.13½	.14
No. 4	color, 750 vis., pale oil	.16	.16½	.16	.16½	.16	.16½
No. 5 to 6	color, 200 vis., red oil	.08½	.09	.08½	.09½	.08½	.09½
No. 5 to 6	color, 300 vis., red oil	.10	.10½	.10	.11	.10	.11
No. 5 to 6	color, 500 vis., red oil	.11½	.12	.11½	.12½	.11½	.12½
No. 5 to 6	color, 750 vis., red oil	.14½	.15	.14½	.15½	.14½	.15½
No. 2	color, 200 vis., pale filtered	.13	.14	.13	.14	.13	.14
No. 2	color, 300 vis., pale filtered	.14½	.15	.14	.15	.14	.15
No. 2½	color, 500 vis., pale filtered	.16	.17	.16	.17	.16	.17
No. 2½	color, 750 vis., pale filtered	.20	.21	.20		.20	
CALIFORNIA—							
130 vis., 2½-3	color	.10½	.11	.10½	.11	.10½	.11
200 vis., 2½-3	color	.11	.11½	.11	.11½	.11	.11½

REFINERY AND CRUDE PRICES

Quotations on Principal Refined Products and Crude Petroleum Markets in All the American Oil Fields



300 vis., 3 -3½ color	.11½	.12	.11½	.12	.11½	.12
350 vis., 3½-4 color	.12	.13	.12	.13	.12	.13
400 vis., 3½-4 color	.13	.15½	.13	.15½	.13	.15½
Red Neutral:						
200 vis., 4½-5 color	.09½	.10½	.09½	.10½	.09½	.10½
300 vis., 5 -6 color	.10½	.11	.10½	.11	.10½	.11
400 vis., 5 -6 color	.12	.13½	.12	.13½	.12	.13½
500 vis., 4½-5 color	.13½	.14½	.13½	.14½	.13½	.14½
500 vis., 5 -6½ color	.12½	.13½	.12½	.13½	.12½	.13½
600 vis., 6 plus color	.13½	.14½	.13½	.14½	.13½	.14½

Note: Bright stocks are not manufactured commercially on the Pacific Coast.

NEW YORK (BAYONNE) REFINERY PRICES

	June 14	June 7	May 31
Gasoline, U. S. Motor, 58-60 437	.09	.09	.08¾
Kerosene, water white, 41-43	.07½	.07½	.07½
*Fuel Oil, bunker "C." 14-16, per bbl.	1.65	1.65	1.65
*Fuel Oil, Diesel, 28-30, per bbl.	2.20	2.20	2.20
Gas Oil, 28 plus	.05½	.05½	.05½
25 pale Paraffin Oil	.11¾	.11¾	.11¾
28 pale Paraffin Oil	.07¼	.07¼	.07¼
285 red Paraffin Oil	.12¾	.12¾	.12¾
250 red Paraffin Oil	.11¾	.11¾	.11¾
225 red Paraffin Oil	.10¾	.10¾	.10¾
200 red Paraffin Oil	.09¾	.09¾	.09¾
Refined Wax:			
120-122 a.m.p., per lb.	.03⅞	.03⅞	.03⅞
125-127 a.m.p., per lb.	.04	.04	.04
130-132 a.m.p., per lb.	.04½	.04½	.04½
135-137 a.m.p., per lb.	.05	.05	.05
Petrolatum, in bbls.; carload lots, per lb.:			
Dark green	.01¾	.01¾	.01¾
Amber	.03¼	.03¼	.03¼
Extra amber	.03⅝	.03⅝	.03⅝
Cream	.05½	.05½	.05½
Lily white	.07	.07	.07
Snow white	.08	.08	.08

*Lighterage 6.5c a barrel extra.

NEW YORK (BAYONNE) EXPORT PRICES

	June 14	June 7	May 31
Gasoline, U. S. Motor, 58-60 437, in cases	.2490	.2490	.244
Kerosene, standard white, in cases	.1615	.1615	.1615
Kerosene, water white, in cases	.1715	.1715	.1715
600 steam refined cylinder stock, in bbls.	.18	.18	.18
635 steam refined	.20	.20	.20
650 steam refined	.22	.22	.22
600 Pennsylvania flash	.26	.26	.26
630 Pennsylvania flash	.34	.34	.34
600 Warren E	.36	.36	.36
600 Oil City E	.24½	.24½	.24½
Light 135 Bright Stock	.42	.42	.42
Dark 135 Bright Stock	.40	.40	.40

LOS ANGELES EXPORT PRICES

	June 14		June 7		May 31	
Kerosene water white	.04¼	.04½	.04¼	.04½	.04¼	.04½
U. S. Motor Gasoline, 53-55 437 e.p.	.05½	.06½	.05½	.06½	.06½	.07

CALIFORNIA CRUDE PRICES

*Standard Oil Co.-Union Oil Co. (Effective April 1, 1927)

Gravity—	1 Fullerton, Seal Beach, Long Beach, Huntington Beach, Richfield, Rosecrans-Dom'gues, Torrance-Inglewood	2 Whittier, La Habra, Montebello	3 Kern River, Newhall-McKittrick, Midway-Sunset, Elk Hills, Lost Hills, Belridge, Buena Vista Hills	4 Coyote	5 Santa Fe Springs	6 Coalinga	7 Wheeler Ridge	8 Santa Maria, Ventura, Orcutt, Salt Lake
14°	.85	.85	.75	.85	....	.75	.75	.85
15°	.85	.85	.75	.85	....	.75	.75	.85
16°	.85	.85	.75	.85	....	.75	.75	.85
17°	.85	.85	.75	.85	....	.75	.75	.85
18°	.85	.85	.75	.85	....	.75	.75	.85
19°	.85	.85	.75	.85	....	.75	.75	.85
20°	.85	.85	.77	.85	....	.76	.76	.85
21°	.86	.85	.79	.86	.85	.77	.77	.85
22°	.87	.85	.81	.87	.85	.78	.78	.85
23°	.88	.85	.83	.88	.85	.79	.79	.85
24°	.89	.85	.85	.89	.85	.80	.80	.85
25°	.90	.86	.87	.90	.86	.81	.81	.86
26°	.92	.87	.89	.91	.87	.83	.82	.87
27°	.94	.88	.91	.92	.88	.85	.83	.88
28°	.96	.89	.93	.93	.89	.87	....	.89
29°	.98	.90	.96	.94	.91	.89	....	.91
30°	1.00	.91	.99	.95	.93	.91	....	.93
31°	1.03	....	1.02	....	.95	.93	....	.95
32°	1.06	....	1.05	....	.97	.95	....	.97
33°	1.09	....	1.08	....	.99	.97	....	.99
34°	1.12	....	1.11	....	1.01	.99	....	1.01
35°	1.15	....	....	....	1.03	1.01	....	1.03
36°	1.18	....	....	....	1.06	....	....	1.06
37°	1.21	....	....	....	1.09	....	....	1.09
38°	1.24	....	....	....	1.12	....	....	1.13
39°	1.27	....	....	....	1.15	....	....	1.15
40°	1.30	....	....	....	....	....	....	....
41°	1.33	....	....	....	....	....	....	....
42°	1.36	....	....	....	....	....	....	....

*Column 1—Long beach, Seal Beach and Huntington Beach crudes, 14 to 32 degrees, inclusive; Richfield and Fullerton, 14 to 30 degrees; Torrance and Inglewood, 14 to 28 degrees; Domingues, 24 to 42 degrees. Rosecrans crude ranges from 14 to 42 degrees, but only Union Oil Co. posts below 24 degrees.

Column 2—Whittier crude, 14 to 22 degrees; Montebello, 14 to 30 degrees.

Column 3—Kern River, Newhall and McKittrick, 14 to 19 degrees; Midway-Sunset, Buena Vista and Elk Hills, 14 to 33 degrees; Lost Hills and Belridge, 14 to 34 degrees.

Column 8—Salt Lake, 14 to 19 degrees, inclusive; Santa Maria, 14 to 30 degrees; Ventura and Orcutt, 14 to 39 degrees. Posted only by Union Oil Co.

CRUDE OIL GRAVITY PRICE TABLE

Gravity—	1 Okla., Kans., N. C. Tex., La.-Ark.	2 Smackover, Ark.	3 Stephens, Ark.	4 Wheeler and Gray Counties, (Texas Panhandle)	5 Crane, Upton Crockett Counties (West Texas)	6 Salt Creek, Wyo.	7 Grade B & Light Crude (G. Coast)	8 Somerset, (South Central Texas)
Below 24	....	1.00	....	....	....	....	....	....
24 to 24.9	....	1.25	....	....	....	....	....	....
Below 25	....	....	....	....	....	....	1.15	....
25 to 25.9	....	....	....	....	....	....	1.17	....
Below 26	....	....	....	....	.70	....	....	....
26 to 26.9	....	....	....	....	.72	....	1.19	....
27 to 27.9	....	....	....	....	.74	....	1.21	....
Below 28	****	....	1.00	....	....	....	....	....
28 to 28.9	1.12	....	1.02	.80	.76	....	1.23	....
29 to 29.9	1.14	....	1.04	.82	.78	1.14	1.25	....
30 to 30.9	1.16	....	1.06	.84	.80	1.16	1.27	....
31 to 31.9	1.18	....	1.08	.86	.82	1.18	1.29	....
32 to 32.9	1.20	....	1.10	.88	.84	1.20	1.31	1.05
33 to 33.9	1.22	....	....	.90	.86	1.22	1.33	1.07
34 to 34.9	1.24	....	....	.92	.88	1.24	1.35	1.09
35 to 35.9	1.26	....	....	.94	.90	1.26	1.37	1.11
36 to 36.9	1.28	....	....	.96	.92	1.28	....	1.13
37 to 37.9	1.30	....	....	.98	....	1.30	....	1.15
38 to 38.9	1.32	....	....	1.00	....	....	....	1.17
39 to 39.9	1.34	....	....	1.02	....	....	....	....
40 to 40.9	1.36	....	....	1.04	....	....	....	....
41 to 41.9	1.38	....	....	1.06	....	....	....	....
42 to 42.9	1.40	....	....	1.08	....	....	....	....
43 to 43.9	1.42	....	....	1.10	....	....	....	....
44 to 44.9	1.44	....	....	1.12	....	....	....	....
45 to 45.9	1.46	....	....	....	....	....	....	....
46 to 46.9	1.48	....	....	....	....	....	....	....
47 to 47.9	1.50	....	....	....	....	....	....	....
48 to 48.9	1.52	....	....	....	....	....	....	....
49 to 49.9	1.54	....	....	....	....	....	....	....
50 to 50.9	1.56	....	....	....	....	....	....	....
51 to 51.9	1.58	....	....	....	....	....	....	....
52 and above	1.60	....	....	....	....	....	....	....

Column 1—Magnolia Petroleum Co. posted new schedule May 5, making price below 33 gravity $1.05 per barrel, with 2 cents increase per degree higher in gravity, taking 33-33.9 gravity at $1.07 as basis, with a top price of $1.45 for 52 and above.

Oklahoma: Prairie Oil & Gas Co., Sinclair Oil & Gas Co., Gypsy Oil Co., March 12; Carter Oil Co., The Texas Company, March 14.

North Central Texas—(Including Ranger, Mexia, Powell, Richland, Wortham, Lytton Springs (Southwest Texas), Iatan and Panola (Magnolia only), Currie, Nocona, Moran and Corsicana light); Texas, Prairie, Sinclair and Gulf, March 12; The Texas Company, Humble Oil & Refining Co., March 14.

Kansas—Prairie, Sinclair, March 12; Carter, Texas, March 14.

Arkansas and North Louisiana—(Caddo, Bull Bayou, Crichton, DeSoto, Haynesville, Homer and El Dorado only); Standard Oil Co. of Louisiana, March 14; The Texas Company, March 14; Magnolia Petroleum Co., Pine Island, Haynesville and Bull Bayou, El Dorado, Gulf Pipe Line Co., March 14.

Column 2—Standard Oil Co. of Louisiana, The Texas Company, Gulf, Atlantic, March 17, Magnolia Petroleum Co. (March 16) posted price of $1 for below 24 degrees and $1.15 for 24 and above. Louisiana Oil Corp. posted following prices effective March 16: Below 24, $1, 24 to 27.9, $1.15; 28 to 28.9, $1.17; 29 to 29.9, $1.19; 30 and above, $1.21.

Column 3—Atlantic Oil Producing Co., March 14.

Column 4—Humble Oil & Refining Co. and Gulf Pipe Line Co., March 14.

Column 5—Humble Oil & Refining Co., Kay County Gas Co. and Gulf Pipe Line Co., March 14.

Column 6—Midwest Refining Co., March 12. All crude over 37 gravity, $1.30 per barrel.

Column 7—Humble Oil & Refining Co. and other major buyers (schedule ends "35 and above"), March 14, with exception of Magnolia Petroleum Co., which stops at 31 degrees gravity. Sun Pipe Line Co. posts 2 cents differential for each degree above 35 gravity and $1.47 for 40 gravity and above.

Column 8—Grayburg Pipe Line Co. and Pioneer Oil & Refining Co., April 7.

****Prices for crude below 28 gravity: Oklahoma, Kansas and Texas, Magnolia Petroleum Co., $1.10, March 12; Arkansas, North Louisiana, March 14. Other companies, 2 cents less for each degree with exception of Humble Oil & Refining Co., which pays $1.12 for crude below 28 degrees gravity.

CRUDE OIL PRICES

OKLAHOMA, KANSAS, NORTH AND EAST CENTRAL TEXAS

*Corsicana heavy (March 14, 1927).... $1.00
Other fields .....See gravity table

*Posted by Magnolia Petroleum Co.

TEXAS PANHANDLE

*Carson County ..... $ .95
*Hutchinson County ..... .95
Gray-Wheeler Counties....See gravity table

*Humble Oil & Refining Co., Magnolia Petroleum Co., Gulf Pipe Line Co. and Kay County Gas Co., March 14.

WEST TEXAS

*Iatan (Same as North Texas)
Crane-Upton-Crockett.....See gravity table

*Includes Howard County and Westbrook Fields. Kay County Gas Co. pays $1.05 for Howard County crude, effective May 21.

ARKANSAS-NORTH LOUISIANA

Cotton Valley (March 17) $1.00
Bellevue (Feb. 24, 1927) 1.25
Urania (March 16, 1927) 1.00
East El Dorado (March 16) 1.00
Other fields .....See gravity table

Note—Cotton Valley and Bellevue, Standard Oil Co. of Louisiana, Gulf Refining Co. and Magnolia Petroleum Co.; Urania, Louisiana Oil Refining Corp.; East El Dorado, Magnolia Petroleum Co.

GULF COAST

(Goose Creek, Hull, Liberty, West Columbia, Orange, Boling, Sour Lake, Humble, High Island, Pierce Junction and Spindletop.)
‡Grade A (March 14) $1.20
Grade B .....See gravity table
*Jennings, La. (March 14) 1.05
†Saratoga, Batson, Dayton (March 14, 1927) 1.00
**Markham (March 14) 1.00

*Gulf Pipe Line Co. †Sun Pipe Line Co. ‡Humble Oil & Refining Co. and other major buyers. **The Texas Company.

SOUTH CENTRAL AND SOUTHWESTERN TEXAS

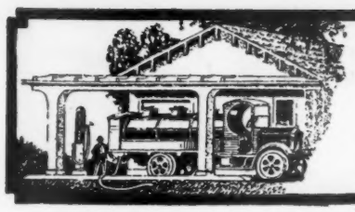
*Luling (May 5) $1.00
†Mirando (March 14) 1.00
Rockdale-Minerva (Milam County) 1.25
*Thrall .....
Callihan (May 15) 1.75
Lytton Springs (Lockhart) See gravity table
Somerset .....See gravity table

*Posted by Magnolia Petroleum Co. Thrall prices same as north central Texas less 19½ cents per cwt. freight.
†Magnolia Petroleum Co., Humble Oil & Refining Co., Crown Pipe Line Co.

ROCKY MOUNTAIN STATES
Ohio Oil Co.-Midwest Refining Co.
(Effective March 14)

Rock Creek, Wyo. (March 12. .....$1.25
Salt Creek .....See gravity table
Big Muddy (March 12) 1.25
Mule Creek (May 1) 1.10
Grass Creek, light (March 12) 1.33
Grass Creek, heavy ..... .98
Elk Basin (March 12) 1.33
Lance Creek (March 12) 1.33
Poison Spider 1.00
Notches ..... .65
Rex Lake (February 23) 1.10
Osage 1.33
Lost Soldier (contract) (May 17) 1.60
Greybull-Torchlight 1.33
Hamilton Dome 1.35
Cat Creek (Mont.) 1.33
Sunburst (Mont.) (October 5) 1.35
Artesia (March 12) 1.00

(Continued on Page 358)



TANK WAGON MARKETS

Tank wagon quotations for gasoline and kerosene in United States as furnished by the larger marketing concerns June 14.

ALL TANK WAGON AND SERVICE STATION QUOTATIONS INCLUDE TAXES

STANDARD OIL CO. (INDIANA)

	Gasoline			Kero.
	Tank wagon	Service station	Incldg tax of	Tank wagon
Chicago dist.	14.0	16.0	...	12.0
Decatur, Ill.	14.2	16.2	...	12.1
E. St. Louis	13.1	15.35	...	11.2
Joliet	14.4	16.4	...	12.3
Peoria	14.2	16.2	...	12.1
Quincy	14.2	16.2	...	10.9
Davenport, Ia.	16.5	18.5	2.0	12.3
Des Moines	16.0	18.0	2.0	12.3
Keokuk	16.5	18.5	2.0	12.3
Sioux City	16.1	18.1	2.0	11.9
Duluth, Minn.	15.5	17.5	2.0	12.9
Minneapolis	14.0	16.0	2.0	12.9
Mankato	15.1	17.1	2.0	12.7
LaCross, Wis.	17.2	19.2	2.0	13.0
Milwaukee	16.1	18.1	2.0	11.9
Madison	16.3	18.3	2.0	12.1
Detroit, Mich.	16.8	18.8	2.0	12.7
Grand Rapids	16.7	18.7	2.0	13.6
Saginaw	16.9	18.9	2.0	13.6
Evansville, Ind.	17.0	19.0	3.0	13.0
Ft. Wayne	17.4	19.4	3.0	13.4
Indianapolis	17.2	19.2	3.0	13.2
South Bend	17.4	19.4	3.0	13.4
Fargo, N. D.	17.0	19.0	2.0	14.9
Huron, S. D.	15.5	17.5	3.0	12.9
Sioux Falls	17.3	19.3	3.0	13.4
K. C. Mo.	14.9	16.9	3.0	10.6
*Springfield	16.8	18.8	3.0	11.5
*St. Louis	15.6	17.9	2.5	11.3
*St. Joseph	16.5	18.5	3.0	11.2
Wichita, Kans.	14.8	16.8	2.0	10.8
Bartlesville, Ok.	15.8	17.8	3.0	10.8

NAPHTHAS

	Tank wagon	Tank car
Oleum spirits	16.0	11.75
V. M. & P. naphtha	18.0	13.75
Cleaner's naphtha	18.0	13.75
Stanisol	19.0	.....

Tank wagon prices f.o.b. Chicago; tank car prices f.o.b. Whiting.

STANOLIND FURNACE OIL

Less than 100 gallons	9.0
100 to 799 gallons	8.0
800 or more gallons	7.5

Tank wagon prices of gasoline subject to discount of 1 cent a gallon on dumps of 50 gallons or more throughout territory except Chicago district where discount applies only to dumps of 100 gallons. Kerosene subject to 1 cent discount on dumps of 50 gallons or more.

Outside the Chicago district, the following quantity discount schedule is in effect on monthly tank wagon deliveries of gasoline: 6,000 gallons or more, 1½ cents; 10,000 gallons or more 2 cents; 15,000 gallons or more, 3 cents. These discounts include the 1 cent allowed on dumps of 50 gallons or more at one delivery.

Within the Chicago district the following quantity discount schedule is in effect on tank wagon deliveries of gasoline: 750 to 2,000 gallons, one-half cent; 2,000 to 3,000 gallons, three-fourths cent; 3,000 to 6,000 gallons, 1 cent; 6,000 to 10,000 gallons, 1½ cents; 10,000 to 15,000 gallons, 2 cents; 15,000 gallons or more, 3 cents. These discounts are in addition to the special discount of 1 cent on dumps of 100 gallons or more at one delivery.

If the quantity bought during the year is equal to or exceeds 12 times the agreed monthly quantity, the discount is paid or credited on the entire quantity at the close of the term less the monthly payments made during the year.

*State tax 2 cents; remainder city tax.

OHIO

Standard Oil Co. (Ohio)

	Gasoline			Kero.
	Tank wagon	Service station	Incldg tax of	Tank wagon
All Ohio points	19.0	21.0	3.0	15.0

SOUTHWESTERN DISTRICT

***Magnolia Petroleum Co.**

	Gasoline			Kero.
	Tank wagon	Service station	Incldg tax of	Tank wagon
Dallas, Tex.	13.0	16.0	3.0	11.0
Fort Worth	13.0	16.0	3.0	10.0
Houston	15.0	19.0	3.0	15.0
San Antonio	13.0	16.0	3.0	11.0
El Paso	17.0	19.0	3.0	16.0
Texarkana	15.0	18.0	3.0	12.0
Muskogee, Ok.	14.0	17.0	3.0	10.0
Okla. City	14.0	17.0	3.0	10.0
Tulsa	14.0	17.0	3.0	10.0
Ft. Smith, Ark.	18.0	21.0	5.0	12.0
Little Rock	18.0	21.0	5.0	12.0

*The following is the schedule of discounts on quantity gasoline sales adopted by the Magnolia Petroleum Co. in Oklahoma: Over 750 gallons a month, one-half cent; over 2,000 gallons, three-quarters cent; over 3,000 gallons, 1 cent; over 4,500 gallons 1¼ cents; over 6,000 gallons, 1½ cents; over 9,000 gallons, 1¾ cents; over 10,000 gallons, 2 cents. If the quantity bought during the year is 12 times the monthly agreed purchases, the discount will be paid or credited on the entire quantity for the year less any monthly purchases.

The schedule on service station deliveries is: Over 200 gallons a month, 1 cent; over 300 gallons a month, 1¼ cents; over 400 gallons, 1½ cents; over 500 gallons a month, 1¾ cents; over 600 gallons, 2 cents. The same rule applies for annual purchases in the tank wagon discounts.

CENTRAL SOUTH DISTRICT

Standard Oil Co. (Louisiana)

	Gasoline			Kero.
	Tank wagon	Service station	Incldg tax of	Tank wagon
*N. Orleans, La.	15.5	18.5	3.0	14.0
Baton Rouge	14.0	17.0	2.0	12.5
Alexandria	16.0	18.0	2.0	14.0
LaFayette	15.0	18.0	2.0	13.5
Lake Charles	15.5	18.5	2.0	14.0
Shreveport	14.0	17.0	2.0	13.0
Knoxville, Tenn.	19.5	22.5	3.0	15.0
Memphis	13.0	16.0	3.0	14.0
Chattanooga	19.5	22.5	3.0	15.0
Nashville	16.5	19.5	3.0	15.0
Bristol	19.0	22.0	3.0	14.0
L. Rock, Ark.	18.0	21.0	5.0	12 0

*Tax of 3 cents includes city tax of 1 cent.
*Louisiana kerosene prices include 1-cent state tax and 1-cent parish tax.

SOUTHERN DISTRICT

Standard Oil Co. (Kentucky)

	Gasoline			Kero.
	Tank wagon	Service station	Incldg tax of	Tank wagon
Atlanta, Ga.	18.0	21.0	4.0	15.0
Augusta	19.0	22.0	4.0	16.0
Macon	19.0	22.0	4.0	16.0
Savannah	18.0	20.0	4.0	14.0
Birm'h'm, Ala.	18.0	21.0	4.0	15.5
Mobile	17.0	20.0	4.0	15.0
Montgomery	19.0	22.0	5.0	16.5
Clarksdie, Miss.	17.0	20.0	4.0	13.5
Jackson	17.0	20.0	4.0	14.5
Natchez	16.5	19.5	4.0	14.0
Gulfport	17.5	21.5	6.0	14.0
Vicksburg	16.5	19.5	4.0	14 0
Jacksonville, Fla.	17.0	20.0	4.0	14.0
Miami	19.0	22.0	4.0	15.5
Pensacola	18.0	21.0	5.0	15.0
Tampa	16.0	19.0	4.0	14.0
Lexington, Ky.	18.0	21.0	5.0	15.5
Covington	20.0	23.0	5.0	15.5
Louisville	19.0	22.0	5.0	15.0

In addition to the state tax of 2 cents on gasoline, Montgomery has city tax of 1 cent on gasoline and one-half cent on kerosene. Prices in Georgia include one-half cent inspection fee on gasoline and kerosene; in Florida, an inspection fee of 0.125 cent; in Alabama, an inspection fee of one-half cent on kerosene only. Pensacola tax includes 1 cent city levy. Gulfport tax includes privilege tax of 2 cents in addition to state tax.

PENNSYLVANIA-DELAWARE AND PART NEW ENGLAND

Atlantic Refining Co.

	Gasoline			Kero.
	Tank wagon	Service station	Incldg tax of	Tank wagon
Pittsburgh, Pa.	16.0	*21.0	...	14.0
Philadelphia	14.0	18.0	...	14.0
Scranton	16.0	*21.0	...	14.0
Allentown	16.0	*21.0	...	14.0
Altoona	16.0	*21.0	...	14.0
Erie	14.0	19.0	...	14.0
Dover, Del.	19.0	22.0	3.0	14.0
Wilmington	19.0	22.0	3.0	14.0
Spring'd, Mass.	17.0	19.0	...	15.0
Worchester	17.0	19.0	...	15.0
Boston	17.0	19.0	...	15.0
Providence, R.I.	18.0	20.0	1.0	15.0
Hartford, Conn.	21.0	23.0	2.0	15.0
New Haven	21.0	23.0	2.0	15.0

*Includes tax of 2 cents. Pennsylvania tax is collected by the dealer and paid by him direct to the state.

NEW YORK AND PART OF NEW ENGLAND DISTRICT

Standard Oil Co. (New York)

	Gasoline			Kero.
	Tank wagon	Service station	Incldg tax of	Tank wagon
Albany, N. Y.	18.0	21.0	...	15.0
*New York	18.0	23.0	...	15.0
Buffalo	18.0	21.0	...	14.0
Rochester	17.0	20.0	...	14.0
Syracuse	19.0	21.0	...	15.0
Boston, Mass.	17.0	19.0	...	15.0
Augusta, Me.	22.0	26.0	3.0	15.0
M'nchest'r, N.H.	17.0	21.0	2.0	15.0
Burlington, Vt.	21.0	23.0	2.0	15.0

*Price in steel barrels.

PACIFIC COAST DISTRICT

Standard Oil Co. (California)

	Gasoline			Kero.
	Tank wagon	Service station	Incldg tax of	Tank wagon
San Francisco	15.0	19.0	2.0	15.5
Pueblo	16.0	16.0	2.0	15.5
Los Angeles	14.5	18.5	2.0	16.5
Reno, Nev.	21.0	25.0	4.0	19.0
Portland, Ore.	16.5	20.5	3.0	16.5
Seattle, Wash.	15.5	19.5	2.0	16.5
Tacoma	15.5	19.5	2.0	16.5
Spokane	19.5	23.5	2.0	20.5
Phoenix, Ariz.	21.0	25.0	3.0	20.5

ATLANTIC COAST DISTRICT

Standard Oil Co. (New Jersey)

	Gasoline			Kero.
	Tank wagon	Service station	Incldg tax of	Tank wagon
Atlantic City	16.0	....	...	14.0
Newark, N. J.	16.0	18.0	...	14.0
Annapolis, Md.	20.0	23.0	4.0	14.0
Baltimore	20.0	23.0	4.0	10.0
Cumberland	20.0	23.0	4.0	14.0
Washington	16.0	19.0	2.0	12.0
Danville, Va.	20.5	....	4.5	14.0
Norfolk	20.5	20.5	4.5	14.0
Petersburg	20.5	23.5	4.5	14.0
Roanoke	20.5	23.5	4.5	14.0
Richmond	20.5	23.5	4.5	14.0
Charleston, W. Va.	19.5	22.5	3.5	14.0
Keyser	19.5	....	3.5	14.0
Parkersburg	16.5	19.5	3.5	14.0
Wheeling	19.5	22.5	3.5	14.0
Charlotte, N. C.	20.0	23.0	4.0	14.0
Hickory	20.0	23.0	4.0	14.0
Mt. Airy	20.0	23.0	4.0	14.0
Salisbury	20.0	23.0	4.0	14.0
Charl'st'n, S. C.	20.0	23.0	5.0	14.0
Columbia	20.0	20.0	5.0	14.0

NEBRASKA

Standard Oil Co. (Nebraska)

	Gasoline			Kero.
	Tank wagon	Service station	Incldg tax of	Tank wagon
Omaha	14.25	16.25	2.0	12.25
McCook	17.75	17.75	2.0	13.75
Norfolk	16.75	18.75	2.0	12.75
N. Platte	17.75	19.75	2.0	13.50
Scottsbluff	17.25	19.25	2.0	13.00

ROCKY MOUNTAIN DISTRICT

Continental Oil Co.

	Gasoline			Kero.
	Tank wagon	Service station	Incldg tax of	Tank wagon
Denver, Colo.	18.0	20.0	2.0	14.5
Pueblo	17.0	17.0	2.0	14 5
Grand Junction	21 5	23 5	2 0	18 0
Casper, Wyo.	18.0	20.0	3.0	13.0
Cheyenne	18.0	21.0	3.0	14.5
Butte, Mont.	22.0	22.0	3.0	19.0
Helena	22.5	24.5	3.0	19.0
Salt Lake, Utah	21.0	24.0	3.0	14.0
Boise, Idaho	23.5	25.5	4.0	19.0
Twin Falls	23.5	25.5	4.0	19.0
Albu'que, N. M.	21.0	24.0	5.0	17.0

TANK WAGON CHANGES

May 16—Standard Oil Co. of Nebraska reduced the gasoline station price 2 cents in Omaha.

May 31—Standard Oil Co. of Nebraska reduced the gasoline tank wagon price 1 cent in Omaha.

June 2—Standard Oil Co. reduced the gasoline station price 2 cents in McCook.

June 5—Standard Oil Co. of Indiana reduced the gasoline tank wagon and station prices 1 cent in Minneapolis.

June 6—Magnolia Petroleum Co. reduced kerosene 1 cent in Oklahoma.

June 8—Continental Oil Co. advanced the gasoline tank wagon and station prices 1 cent throughout Colorado with few exceptions. In Denver the station price was advanced 2 cents.

June 9—Magnolia Petroleum Co. advanced the gasoline tank wagon and station prices 2 cents in Dallas.

June 9—Standard Oil Co. of Louisiana advanced the gasoline tank wagon and station prices 1 cent throughout Arkansas to equalize the increased tax from 4 to 5 cents effective on that date.

June 10—Standard Oil Co. of Indiana reduced the gasoline tank wagon and station prices 2 cents in Duluth and Kansas City.

June 13—Magnolia Petroleum Co. advanved the gasoline tank wagon and station prices 2 cents in Fort Worth and San Antonio.

NORTH TEXAS MARKET

WICHITA FALLS, Tex., June 13.—A good movement of gasoline with firm prices bolstered with a 2-cent tank wagon raise in Fort Worth June 13, led in activity all refined products in the North Texas market. Natural gasolines, kerosene and fuel oil were further weakened.

The steady dropping of natural gasoline and the inability of manufacturers to move it is causing some alarm. A 600-car order last week in North Texas failed to strengthen the market. Some plants are so hard pressed for storage tank cars are being used. Other manufacturers are building additional storage. Manufacturers who made contracts a few weeks ago at around 6⅛ cents are still filling those orders.

Refinery gasoline was steady, with a good movement. Buyers were fairly active in buying over June, and one Fort Worth refiner sold 75 cars over June at 6¾ cents. A slight slump is expected in the spot market early this week as a result of storms.

Another indication of improvement is report of a few refineries starting up their cracking plants. The resumption is expected to furnish a little strength to fuel oil markets. Expected railroad buying in fuels is expected within a week.

Kerosene was weaker for several weeks. One factor was pointed out by a refiner selling extensively in the Plains country of the Panhandle. Tank wagon prices on gasoline in that area are too near the tank wagon price on kerosene and gasoline is being used as tractor fuel. The drought there cut deeply into sales. More plowing is expected within a few weeks as the result of a heavy and general rainfall.

While weak gas oil showed signs of strengthening as the result of heavy movements north. Little distillate is being moved and the product is weak.

PENNSYLVANIA MARKETS

OIL CITY, Pa., June 11.—Gasoline in the Pennsylvania refined market district looks better than for some time. The movement is better and the price structure seems to be firmer. Demand for kerosene continues about the same, but the prices are lower in some instances. Neutrals continue to be very strong, in good demand and scarce. Fuel oil is very weak. There is no demand to amount to anything for cylinder stocks and the movement is not so good. There was no change during the week in bright stocks. Wax is somewhat stronger.

CRUDE OIL PRICES

(Continued from Page 357)

Hogback (N. Mex.) (March 14)	1.30

Note: Salt Creek, Osage, Cat Creek, Greybull and Hogback posted by Midwest Refining Co., and the remainder by the Ohio Oil Co. Both companies post Grass Creek light and Elk Basin.

EASTERN STATES

Joseph Seep Purchasing Agency
(Effective March 7)

Penna Grade Oil in New York Transit Line (New York)	$2.90
Bradford District Oil in National Transit Lines (Pennsylvania)	2.90
Penna Grade Oil in National Transit Lines (Pennsylvania)	2.80
Penna Grade Oil in Southwest Pennsylvania Lines (West Virginia)	2.80
Penna Grade Oil in Eureka Pipe Line lines (Pennsylvania)	2.75
Penna Grade Oil in Buckeye Pipe Line Lines (Ohio)	2.60
Cabell Grade Oil in Eureka Pipe Line Lines (West Virginia) March 16	1.40
Corning 35-cent grade oil in Buckeye Pipe Line Co.'s line (March 17)	1.35
Corning 25-cent grade oil in Buckeye Pipe Line Co.'s lines (March 17)	1.45
Somerset Oil in Cumberland Pipe Line Lines (Kentucky) March 16	1.50
Ragland Grade Oil in Cumberland Pipe Line Lines (Kentucky)	.95
Kenner (Pennsylvania)	1.10

MIDDLE WESTERN STATES

Ohio Oil Co.
(Effective March 14)

Lima	$1.71
Wooster	1.77
Illinois	1.60
Indiana	1.48
Princeton	1.60
Plymouth	1.33
Waterloo (Nov. 17, 1926)	1.35
*Western Kentucky	1.33
**Saginaw, Mich., Berea Sand (May 27)	1.95
**Saginaw, Mich., Saginaw Sand (May 27)	2.05
†Cumberland, Barren, Clinton and Monroe Counties, Kentucky (March 16)	1.50
‡Oil in lines of Stoll Oil Refining Co. in Oil City, Ky. (March 16, 1927)	1.50
†Clay County, Tennessee (November 18	2.35
§Oil Springs (Canada)	2.18
§Petrolia (Canada)	2.11

*Posted by Ohio Oil Co.
†Posted by Paragon Development Co.
‡Posted by Stoll Oil Refining Co.
§Posted by Imperial Oil Co., Ltd.
**Posted by Sun Oil Co.

*Tuxpam light (f.o.b. Mex. ports)	$1.35
†Panuco heavy (f.o.b. Mex. ports)	1.15
Tuxpam (New York)	2.15
Panuco (New York)	1.80

*Plus 32.328c tax. †17.631c tax.

This SIGN

is for the dealer who builds his business on the solid foundation of Good Will

WHEN a Dealer displays this sign, his business grows! Why?—because back of this sign is a successful method for giving motorists *correct lubrication!*

When a man drives his car in for oil, the Authorized Opaline Dealer looks at the speedometer and finds out the car's mileage—then he looks at the Sinclair Recommendation Index and finds out which grade of Opaline Motor Oil the car needs. He gives the motorist exactly the right grade to fit the degree of wear in the engine as indicated by the mileage.

May we tell you about this successful method of selling *correct lubrication* with the full line of Opaline Motor Oils?

SINCLAIR REFINING COMPANY, INC.

Also Makers of Sinclair Gasoline and H-C Gasoline

45 NASSAU STREET, NEW YORK

Atlanta Boston Chicago Houston Kansas City

Entire contents copyrighted 1927 by Sinclair Refining Company, Inc.

Oil Securities Were Strong and Active

Several Issues Reached New High Prices for the Year. Standard Companies Among the Features

By N. O. Fanning

New York Bureau, The Oil and Gas Journal, Room 629, No. 101 Park Avenue, New York, N. Y.

NEW YORK, June 13.—Oil securities were strong and active during the past week many new high prices being recorded. Standard Oil securities were featured with Chesebrough Manufacturing, Union Tank Car, Atlantic Refining, Illinois Pipe Line and Prairie Pipe Line most active. The Oil and Gas Journal average rose to 59.91, the highest mark since February. The Stock Exchange was closed today in honor of Lindberg's arrival.

Marland Oil

J. P. Morgan & Co., Guaranty Trust Co., First National Bank, National City Co. and F. S. Smithers & Co. are offering today $30,000,000 5 per cent serial gold notes of the Marland Oil Co. The notes mature in four installments of $7,500,000 each, in 1929, 1930, 1931 and 1932. The two-year notes are priced to yield 5.30 per cent, the three-year notes 5.35 per cent, the four-year notes 5.45 per cent and five-year notes 5.50 per cent.

Royal Dutch

The report of the Royal Dutch Co. for the year ended December 31, 1926, shows net income of 191,595,945 florins after expenses and taxes, equivalent after dividends on the preferred stocks, to 24.3 per cent on 412,103,000 florins ordinary stock. This compares with net income of 94,500,194 florins, or 23.1 per cent, on 402,451,000 florins ordinary stock outstanding in 1925.

The balance sheet of the Royal Dutch Co. as of December 31, 1926, compares with 1925 as follows (figures in Dutch florins):

Assets

	1926	1925
Unissued shares	157,897,000	162,791,000
Investments	419,442,507	363,770,791
Cash	96,634,752	142,845,607
Debtors	87,324,579	73,451,920
Interim div. prior shs.	641,250	641,250
Total	761,950,088	743,500,568

Liabilities

Ordinary shares	570,000,000	570,000,000
Pref. shares	1,500,000	1,500,000
Priority shares	28,500,000	28,500,000
Uncl. dividends	2,499,432	764,829
Creditors	846,717	1,990,124
Unit. divs.	268,397	1,969,751
Reserves	56,729,597	44,275,670
P. & L. surplus	101,595,945	94,500,194
Total	761,950,088	743,500,568

The Dutch florin is now equivalent at present rate of exchange to about 40 cents.

Sir Henri W. Deterding, managing director of the Royal Dutch Co., states that consumption of oil is constantly expanding over various lines and adds that there need not be any present fear of exhaustion of oil because of this large demand. Deeper drilling uncovering new reserves, inventions enabling greater extraction of products from oil, and more economic and scientific use of products which make for continuity of supply.

Production of crude oil by the Royal Dutch Shell group in 1926 was 15,536,651 metric tons (7½ bbls. to a ton), compared with 13,927,392 metric tons in 1925.

Second Quarter Dividends

Cash dividends paid by the various companies comprising the Standard Oil group in the second quarter of 1927 will amount to $54,275,766, according to compilation of C. H. Pforzheimer & Co., specialists in Standard Oil securities. This total, despite unsettled conditions in the petroleum industry, establishes a new high record for any corresponding quarter in previous years.

Second quarter dividend payments compare with $55,873,413 in the first quarter and $50,618,451 in the second quarter of 1926. Dividends for the first half of 1927 aggregate $110,149,179 against $109,112,826 in the previous six months and $91,198,768 in the first half of last year. Dividends paid in the first quarter of this year included $990,000 extra by Cumberland Pipe Line and $1,000,000 extra by Southern Pipe Line, both payments representing partial liquidation of securities outside of the companies' business. In the second quarter Crescent Pipe Line paid out $916,800, representing a payment of $15.28 a share in final liquidation.

The primary reason for the decline in dividend payments in the second quarter as compared with the first quarter of the year was due to the retirement of the preferred stock issue of the Standard Oil Co. of New Jersey, on which quarterly dividend payments amounted to $3,499,525. This, however, was partially offset by an increase in the common stock of that company. The company maintained the extra dividend of 12½ cents a share in addition to the regular payment of 25 cents a share on the increased amount of stock which resulted in an increase in dividends on the common stock of approximately $1,300,000. Standard Oil Co. of California omitted the extra dividend of 12½ cents a share which was paid in the first quarter of the year, which accounted for a reduction of $1,574,262 in the quarterly payment. Standard Oil Co. of Kentucky also omitted the extra dividend of 50 cents reducing the payment by about $400,000 and Continental Oil Co.'s dividends were approximately $200,000 less.

The record of the quarterly cash disbursements since the dissolution is as follows:

	First Quar.	Second Quar.	Yearly Totals
1927	$55,873,413	$54,275,766	.....
1926	40,580,317	50,618,451	$200,321,594
1925	34,355,618	41,905,728	153,506,099
1924	34,975,867	40,699,592	150,388,555
1923	33,499,988	36,311,251	138,423,295
1922	28,206,068	29,205,349	129,039,865
1921	28,987,611	29,131,727	115,294,292
1920	26,796,606	27,313,396	115,776,793
1919	26,759,502	26,397,119	105,901,477

Penn Mex Fuel

Penn Mex Fuel stock advanced about 10 points on the announcement that the Supreme Court in Mexico City had decided in favor of the company in the suit brought by Nunez and Rocha for approximately 8,000,000 pesos in connection with the Alamo oil property. Penn Mex had held up development work pending settlement of the case, but will now resume operations. Three wells will be drilled in the Paso Real district.

Texas Pacific C. & O.

The Texas Pacific Coal & Oil Co. has received $900,000 from the Government in settlement of the remainder of its claim on overpayment of Federal taxes in previous years. The company now has $1,700,000 cash on hand. At the close of 1926 its balance sheet showed the item of $900,000 as due the company on its claim of tax overpayment.

Union Tank Car

L. J. Drake, president of the Union Tank Car Co., states that the company is building and planning conservatively on a firm foundation. The outlook for the year and subsequently is satisfactory, he states, although there are no developments out of the ordinary in prospect.

Humble Oil & Refining

The Humble Oil & Refining Co. has declared an extra dividend of 20 cents and the regular quarterly dividend of 30 cents, both payable July 1 to stockholders of record June 11. Sinclair dividends were paid in four preceding quarters.

NEW YORK EXCHANGE—LIST OF ACTIVE STOCKS

Stocks—	Par	Clos. Quot. June 13	Clos. Quot. June 6	1927 High	1927 Low	1926 High	1926 Low	1925 High	1925 Low
Amerada Corp.	..	31⅜	32½	37⅝	30⅜	32⅞	24⅜	..	..
Atlantic Refining, com.	100	124⅛	114½	125⅝	107	128⅝	97	117½	95½
Barnsdall "A"	25	28	26	35½	26⅜	32½	23½	33½	18¾
California Petroleum, com	25	24⅜	24½	32⅜	24⅜	38⅛	30⅞	34⅜	23⅜
Houston Oil	100	162⅛	161	162½	60⅛	75	50¼	85	59
Independent Oil & Gas	..	19	19	32⅜	19⅛	34	20½	41¾	13½
Louisiana Oil	10	12½	11⅝	18⅛	12⅝	19⅝	12	23¾	13¾
Maracaibo	..	14½	*13½	22⅜	15	27⅜	18⅜	35½	20⅜
Marland	..	36	37	58⅛	37½	63⅝	49½	60⅛	32⅝
Mid-Continent Petroleum	..	31½	31¾	39⅜	30⅞	41	25⅝	38	25⅜
National Supply	50	79½	80	95⅜	82½	84⅞	55½	71	54⅜
Oil Well Supply	25	37⅜	40⅜	44⅜	31¼	36	30	38	33⅜
Pan American, B	50	57½	58	65⅞	57⅛	72⅜	56⅛	83⅞	55½
Pan American, Western B	..	20⅜	*18⅜	37⅞	26⅞	46	34	94⅜	37¼
Phillips Petroleum	..	43⅜	42⅞	60¼	41⅛	54⅞	42⅛	47⅛	30⅛
Producers & Refiners	50	29½	30⅛	33⅞	16⅜	26	11	32⅝	12½
Pure Oil, com.	..	26⅝	26⅛	32⅝	26⅜	31	25⅜	33⅜	25½
Royal Dutch, N. Y., sh.	13.40	49	*50	54½	50	57⅜	49⅜	57⅞	48¼
Shell Transport	10	45¼	*45½	49	44½	48⅜	42	49	39⅜
Shell Union, com.	..	27⅜	27⅝	31⅝	26⅞	30⅞	24	28⅜	21⅝
Simms Petroleum	10	16¼	16½	22⅜	18⅞	28⅝	16½	28½	18⅜
Sinclair Consolidated	..	17	16⅞	22⅜	17⅝	24⅞	16⅜	24⅞	17
Skelly Oil	25	27⅝	27½	37⅜	26⅞	37½	27	32½	21⅜
Standard of California	25	54⅜	53½	60⅜	52⅝	63½	54	67¼	52½
Standard of New Jersey, com.	25	37⅝	36⅞	11⅜	36	46⅜	37½	47½	38⅜
Standard of New York	25	30½	30½	34⅛	31	47¼	30⅝	48⅝	40
Sun Oil Co.	..	31⅜	31	34⅞	30	41⅝	30⅛	43⅞	38½
The Texas Company	25	48⅛	48¼	58	43⅜	58	48	55	43⅜
Texas Pacific Coal & Oil	10	15	12⅜	18⅞	13	19½	12⅛	23⅜	11
Tide Water Associated Oil	..	18	16⅜	23½	16½	21	17	..	..
Transcontinental	..	6⅜	5½	7½	4⅛	5½	3	5⅝	3½
Union Oil of California	25	42⅞	43	56½	39⅝	53⅜	37½	43⅝	33½
Union Tank, com.	100	114	110⅛	115½	95	120⅜	84¼	134	118
White Eagle Oil & Refining	..	23½	23½	27½	22	29⅜	25⅛	21⅜	25⅝
Standard Oils									
Anglo-American Oil	£1	18½	*19⅞	21⅝	18¾	19¾	16½	26¾	17½
Borne Scrymser	25	55	*51	69	53¼	75	65	‡240	205
Buckeye Pipe Line	50	59	*57½	59	59½	47⅝	47⅝	72	63½
Chesebrough Manufacturing Co.	25	110	105	115	76½	81⅛	63	74	98¼
Continental	10	17⅞	17¾	22⅜	18	25⅞	19¼	31⅛	21⅞
Cumberland Pipe Line	100	93	*92	137	106	137	102	156	128
Eureka Pipe Line	100	56	56	51¼	47	53⅜	43	96	61¼
Galena Signal, com.	100	*9	*7½	13½	10¼	32½	9⅞	68½	23½
Humble Oil & Refining Co.	25	58½	56¼	62⅜	54	99⅝	52	99	42½
Illinois Pipe Line	100	143	141	150	123⅜	144	131	154½	124
Imperial Oil	..	43½	43⅜	46	37⅜	39¾	32½	39¼	27¼
Indiana Pipe Line	50	70	*70	72½	61	68	52¼	84	87½
International Petroleum Co.	10	30½	30	34⅞	30⅛	35¼	28⅜	25⅜	22⅛
National Transit Co.	12.50	16	16⅛	14	13⅝	30¾	27¼	25½	16½
New York Transit	100	36	34	36	31¼	51½	27½	70	50
Northern Pipe Line	100	91	87	91	70	80½	64	88	67½
Ohio Oil Co.	25	57	56¼	64¼	57½	67¾	55¾	75¼	60
Penn-Mex Fuel	25	27	27	31	16½	24¼	15	44	19
Prairie Oil & Gas	25	48	48	55½	48¼	60¼	48	65½	45⅞
Prairie Pipe Line	100	171	165¾	177	132	137½	122½	129¾	105
Solar Refining Co.	100	*180	*180	101½	185	212	181½	159	200
South Penn Oil	25	36⅛	36	41½	35½	50	35	‡197	138
Southwest Pa. Line	100	75	*72	62½	55½	56	47½	84	50
Southern Pipe Line	50	*18	*18½	27¼	15½	27	24	‡103	63
Standard of Indiana	25	67⅝	67⅞	74¼	66½	10½	61⅝	70¾	69¼
Standard of Kansas	25	16⅛	16	20¾	15⅝	36½	16½	46	30¼
Standard of Kentucky	25	113	112¾	122¼	114¼	134⅜	108	137	114⅜
Standard of Nebraska	25	45¼	*45½	49½	46½	51¼	42	‡270	231
Standard of Ohio, com.	100	77½	74⅜	254	335	362	192½	369	338
Swan & Finch, com.	25	*17	*15	16	15	21	18	27	12
Vacuum Oil	25	125⅜	132¼	134	95⅛	109⅜	94⅛	109½	80½
Miscellaneous									
Gulf Oil Corp. of Pa.	25	91⅛	89	96½	92⅛	95	82½	98¼	63½

*Bid, no sales. ‡Old stock. †New stock.

The Oil and Gas Journal's weekly average price of 20 representative petroleum stocks listed on the New York Stock Exchange was as follows:

June 13	59.91	May 9	58.08	Apr. 4	56.63
June 6	59.27	May 2	57.13	Mar. 28	58.51
May 28	58.68	Apr. 25	57.03	Mar. 21	58.03
May 23	57.89	Apr. 18	57.42	Mar. 14	59.26
May 16	58.10	Apr. 11	57.37	Mar. 7	59.34

CALIFORNIA MARKET AFFECTED BY WEATHER

LOS ANGELES, Calif., June 10.—There have been no outstanding developments in the California oil market during the past week. The domestic demand for gasoline is good but has not improved as usual at this time of year, due to continuation of unusually cool weather. In some quarters there is a rumor that gasoline prices are about to be increased in anticipation of the summer demand now overdue. This rumor seems unfounded as prices are soft with no immediate reason in sight for improvement. Competition continues keen, another reason why it is doubtful if prices will be raised.

Marketers are closely watching developments at Alamitos Heights as it is felt that this field has an important bearing on the future market. Unless a new deep sand is found, however, this field is not expected to reach the production figure at first forecast for it. When production from Alamitos Heights is definitely on the down grade, marketers will feel more optimistic.

The natural gasoline market is showing no improvement. Production continues at a high figure in excess of demand. Spot sales are being made at around 7½ cents. Contract sales, which are few in number, are at around 10 cents. This market has been marking time for two weeks.

Demand for lubricating oils is improving, moving along with gasoline sales. Lubricating oils have been weak for several months and continue so. The price structure is not very well defined and in even the retail market, lubricating oil can be bought at certain service stations at greatly reduced figures. In the majority of instances this oil is not of a standard grade but of an inferior quality sold by some of the larger refiners. It is doubtful if the lubricating oil market will strengthen much during the next few months.

AUSTRALIAN OIL ADVISER

Walter Woolnough, of Sydney University has been appointed the Australian Government's adviser on petroleum. The appointment is accepted as evidence of the government's intention to do everything possible to find oil in Australia. Woolnough will make thorough investigation in Australia, New Guinea and Papua.

WIDER DISTRIBUTION IS KEYNOTE OF CONFERENCE

(Continued from Page 38)

to the top of Pike's Peak and drive the ball from there.

"Yes," he said, "and you will probably top the ball."

The main committees on standardization which will formally open their meetings tomorrow and continue them during the next three days include those on "Belting," A. H. Riney, national chairman; "Boilers," S. J. Dickey, national chairman; "Cable Tool Drilling Joints," Thomas Fleming, Jr., national chairman; "Standard Rigs and Derricks," W. W. Fondren, national chairman; "Oil Country Tubular Goods," J. Edgar Pew, national chairman; "Rig Irons," H. J. Lockhart, national chairman; "Rotary Drilling Equipment," Capt. J. F. Lucey, national chairman; "Wire Rope and Manila Cordage," C. C. Sharpenberg, national chairman; "Pumping Equipment and Engines," T. E. Swigart, national chairman, and "Steel Tanks for Oil Storage," Ralph J. Reed, national chairman. Headquarters will be maintained during the conference by C. A. Young, director of standardization for the American Petroleum Institute.

GASOLINE AND GAS OIL FIRM AT SHREVEPORT

SHREVEPORT, La., June 13.—Practically the only activity in Arkansas and north Louisiana refinery markets the past week was in gas oil, for which there is a fair demand from the rice-growing districts and for tractor fuel. Other products were at a standstill and on Monday the business was none too encouraging, and markets somewhat uncertain.

Gas oils were firm from 3¼ to 3½ cents in both Arkansas and Louisiana with refineries well sold up. Unless the supply is increased a reasonably firm to strong market may be expected. Numerous inquiries come in for gas oil prices for material to be shipped north next season for burner oil use, but no contracts are being closed, as buyers are not willing to pay 4¼ or 4½ cents being asked by refiners.

Motor fuel, which is 56-58 437 end-point gasoline in north Louisiana, suffered a little reaction in demand but with refiners generally in good position. Having but a little material available there was a strong tendency to advance quotations. Several substantial orders for 6½ cents were turned down, with sellers asking 7 cents for local shipment and 3¾ cents for interstate movement. Arkansas refiners reported getting 7½ cents for shipment within the state.

Practically no kerosene is available except from one source, asking a minimum of 4¾ cents for 41-43 water white material. Demand is not active, the firm price being due chiefly to a general reduction in production.

Fuel oils continued a dead issue with no spot demand. Louisiana refiners are quoting $1.15 and in Arkansas $1.12½ to $1.15 is being asked for refinery fuel. Natural gasoline for shipment out of Monroe were softer, being quoted at lower prices than out of north Texas and Oklahoma. Several orders were placed Monday by refiners here for Grade Double A on the basis of 5 cents, Group 3.

STEEL PRODUCTS CO. AT WICHITA FALLS

The Panhandle Steel Products Co. of Wichita Falls, Tex., incorporated June 1, has taken over the business of what was formerly the tank and steel structural department of the Panhandle Refining Co. Officers of the company are: Roy B Jones, president; John Tancred, vice president and general manager; W. D. Brookover, vice president; M. A. Chambers, treasurer; R. C. Stanford, secretary. Chris Helmcamp is plant superintendent and R. K. Alexander chief engineer.

The company announces it will carry in stock a diversified assortment of trusses, columns, I-beams, girders, lintels, flat bars, angle irons, H-columns channel iron and many other articles of steel.

OLDEST PIPE LINE MAN PASSES; SUGGESTED FIRST GATHERING LINE

OIL CITY, Pa., June 11. — A. W. Smiley, oldest pipe line man in point of time from his first employment, died at his home in Foxburg, Saturday morning, June 4, after an illness of several weeks. He was a worker on the first pipe line every built and was one of the owners of the first gathering system. He was also influential in building and operating the first railroads in Clarion County.

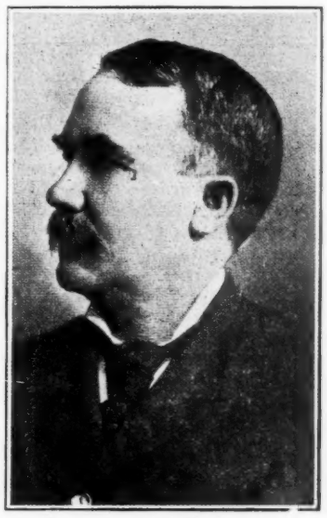
Mr. Smiley was born near Union City, Erie County, on July 16, 1843.

The first trip of Mr. Smiley into this section ended at Titusville, when he arrived with hundreds of others in 1860. Being a strong active boy, 17 years old, he soon found employment helping to kick down a well not far from and in sight of the Drake well. From that time until 1865, Mr. Smiley lived in various places in the oil regions, principally at Titusville and Franklin. On July 1, 1865, he secured employment as timekeeper and paymaster for the force at work building the Pithole and Miller farm pipe line, the first ever placed in use. The idea of transporting the oil by a pipe line was conceived by Samuel Van Sickle, of Titusville, H. C. Ohlen and Reed and Cogswell, of New York. The line extended from Pithole to Miller farm consisting of 6 miles of 2-inch pipe. It was completed in October, 1865. Mr. Smiley said he considered himself lucky to secure lodging the first night he spent in Pithole in the shavings under a carpenter's workbench. During his stay in Pithole he became president of the Swordmen's club, one of the leading social organizations famous in oil country history for many years.

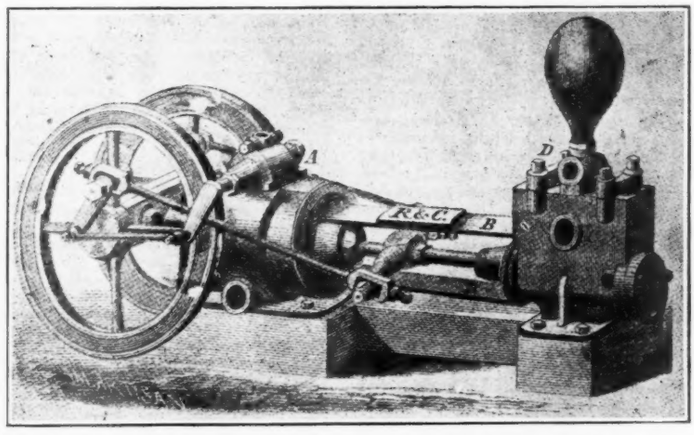
After the completion of the first pipe line, Mr. Smiley was made assistant superintendent and general agent, having charge of the buying department of the Pithole end.

Mr. Smiley was the first man to suggest and put in operation the gathering system. In the summer of 1866 in company with George E. Coutant of New York, Mr. Smiley built what was known as the accommodation pipe line. This line extended over the flats along Pithole Creek, connecting direct to tanks at the best wells. The business of the line was to transfer oil from tanks at wells to the pump stations of the different through lines. This marked a new era in the transportation of oil and in a short time the barreling and hauling of oil by wagons faded into history. The outfit of the accommodation line consisted of one 40-horsepower boiler, one 12 by 8-inch pump, two 250-bbl. tanks and about 4 miles of 2-inch pipe. The charge made was 25 cents a barrel and in some cases the transfer was less than a stone's throw in length. Mr. Smiley was the first man to invent run tickets, the first form prepared by him having been printed at the office of the Pithole Record.

Mr. Smiley remained with the Pithole and Miller farm line until the failure of Mr. Van Sickle. In the spring of 1868 he went to Shamburg, where he built and operated a refinery which continued in his possession until 1869. In 1870 he became agent for the Titusville Pipe Co., at Shamburg. In 1872 he became superintendent of the Mutual line, with headquarters in Foxburg, where he had since made his home. Under his supervision the line was extended until it covered all the producing territory as far as Elk City in Clarion County and all north of Parker on the west side of the Allegheny River. He was with that line until it was taken over by the United. Then he became buyer of crude oil for the Joseph Seep Purchasing Agency, which position he held until the office at Foxburg was closed and he was pensioned.



A. W. SMILEY
From a picture taken in his prime.



The first pipe line pump, used on Pithole and Miller Farm line Oct. 1, 1865.

SKELLY GIVES VIEW OF EXPOSITION BOARD

(Continued from Page 46)

give the industry the advantage of study in a concise form.

Realizing that economy should prevail if the object sought was economy, the exposition board unanimously decided to change the whole method of this year's exposition, eliminating carnival pageant features and putting all effort into the presentation of a scientific and technical display.

In former years I could not see the advantage of the removal of the exposition, even though we were staggering under an unbearable debt with large taxation and interest charges which could be eliminated by moving to the State Fair Grounds in the eastern part of the city.

In the past there was limited transportation to the fair grounds. This year, however, Twenty-first Street, a wide thoroughfare, is paved to the grounds. Eleventh Street, another artery of traffic, approaches by Harvard Avenue and contracts have been let for paving which will be completed, opening Fifteenth Street directly into these grounds.

In addition, the Oklahoma Union Railway Co. is extending its street car lines into the exposition property. Bus lines are already established. The Frisco Railroad is arranging for freight facilities just east of the grounds, while the Oklahoma Union Railway has arranged with the M. K. T. Railroad to tap their line close by. All of these, together with the fact that we could eliminate some $20,000 annual costs in interest and taxes, and secure in lieu thereof a free permanent site much larger than the old grounds, unhampered by railroad switch yards, brought about our decision to move this year.

In our contract with the State Fair we are not bound down to exhibit simultaneously with the fair, but we felt that the State Fair will be an asset to the Exposition, because we realize that there must be entertainment for women and children who cannot be expected to have the same interest in machinery that men would have.

In former years we have spent many thousands of dollars to provide this feature, and on account of limited space were compelled to have much of this down town and the balance, which was held on the grounds, so close to the displays as to interfere with the exhibitors.

Before we decided to move we consulted with the State Fair board and found that they were going to expend as much money for new buildings this year as we are, and that in addition, they had contracted for around $30,000 worth of entertainment which is scheduled for late in the afternoon. Heretofore, parades and other down town entertainments have taken much of the day and lured the people away from the exposition. Under the present arrangement, the greater part of the day will be left free for the inspection of the Petroleum Exposition. Of course, we shall have music and other suitable free entertainments calculated to increase the drawing power and revenue of the exposition without decreasing the interest in the exhibits.

Fortunately, the construction design of the Exposition buildings is of such character as to insure quick construction. Our buildings are already dismantled and removed from the old property and construction is well under way, assuring completion practically 60 days before the opening date. Arrangements have already been made for the installation of electric light, power, gas and water service.

We are gratified with the early response from manufacturers and jobbers, considering the short time the exhibit space has been on the market. More than 40 per cent of the space has been actually contracted for and accompanied by the usual 50 per cent cash payment, while an equal per cent has been reserved on which contracts are being closed and money paid daily.

We have been making a canvass of the various oil and refining companies relative to their participation in the Exposition. The Skelly Oil Co. is now arranging to schedule its field men and other employes for attendance at the Exposition, and I have been assured by other firms in the industry of similar participation.

Of course we sincerely want The Oil and Gas Journal to help as it has in the past. We thoroughly appreciate your interest in the welfare of the industry and we know that your cautious approach is well grounded in a sincere desire to do what is best. All of us sincerely hope that your further investigations will make it possible for The Oil and Gas Journal to take its place where it has always been, well in the foreranks of this worthy enterprise.

Sincerely yours,

W. G. SKELLY.

Trend in Distillate Market Uncertain

Heavy Stocks and Cracking Complicate Situation in North Louisiana and Arkansas Refining Areas. Specifications Given

By Neil Williams

SHREVEPORT, La., June 11.—As far as the North Louisiana and Arkansas refining district is concerned, the outlook for a furnace oil market for next season is an uncertain proposition, and, to use the words of the fraternity here, any future business transacted at this time would be a gamble on the part of either the buyer or seller.

A number of buyers have been attempting to take advantage of the present low prices here and make contracts on the basis of these quotations for autumn and winter material, but such offers have been unattractive to refiners, and, as the matter stands, a virtual deadlock is in force.

It is in this situation that the uncertainty lies. In previous years market students have been able to formulate some idea of trends, and, with conditions more or less defined, sellers and buyers have been able to get together on a price representative of an average market for the ensuing season.

Refiners in this district are free to admit that a sale on today's quotations or slightly above might turn out a good deal for next season, taking it as a whole, but they are not willing to gamble to that extent considering the present low prices. On the other hand, buyers do not deny that these prices are lower than usual, and, that in season, judging from previous experiences, furnace oils might be expected to be worth more then than now.

In this district distillates, or products answering full distillate specifications both as to gravity and distillation, are not manufactured in marketable quantities. Thus, furnace oil virtually means gas oil. The crude on which refiners here operate is generally of low gravity and when the lighter gasoline fractions are cut the residuum consequently is too heavy to meet customary distillate gravity requirements.

Gas Oil Market

This gas oil during the acute tightness for several weeks in the late winter and early spring this year moved out of Arkansas and North Louisiana refineries as high as 5 and 5¼ cents on the open market. It is this fact which really is the disturbing influence in holding up future trading at this time because whether this product will be worth this much, more or less, is a matter of considerable speculation.

Looking at a 5 and a 5¼-cent market, which they enjoyed for a time last season, refiners are not ready to accept offers of 3, 3¼ or 3½ cents being made by those seeking contracts. But, as the 5 to 5¼-cent market existed for only a comparatively brief period, and since then prices have dropped to a low of 2½ and 2¾ cents, there is very little inducement for a buyer paying much more.

It is conceded by the trade here that furnace oil consumption next season will be as great, if not greater, than last autumn and winter. Although having no definite information here on which to base consumption estimates, it is known that last winter was unusually mild on the whole over the northern states and it is not likely that consumption could be any lighter even if no new burners are being installed. But, reports from those states would indicate that there will be a big gain in the number of burners installed.

However, as far as refiners in this district are concerned, the market next season will not hinge on the increased demand for furnace oil, but rather on the supply and other conditions which loom as possible offsetting factors.

Factors in Situation

Unless there is an unusual scarcity of distillates and gas oils in other refining centers, it will be some time before a heavy consumption alone of products suitable for burners would be reflected at refineries here, due to two important factors:

First, last season's comparative mildness caused any number of marketers and distributers of furnace oil to overbuy. A few flurries of cold and bad weather, especially in February, resulted in buyers placing substantial orders with refiners, and, in the ensuing mild weather the material could not be disposed of readily.

Louisiana and Arkansas refiners having a furnace oil possessing natural zero cold test properties desirable in the colder climates were among the principal sellers. The great bulk of this gas oil bought during the season's last cold flurry never has been moved out of this district and still is in refinery storage here under various arrangements with the buyers.

Some unreliable buyers shirked out of their deals and refiners have been getting rid of this material the best way possible since then, but at much lower prices than it originally was purchased. But, the larger and reliable companies made arrangements with refiners here to store this gas oil to their account for the coming season.

The latter material is one barrier in the way of any immediate demand at refineries here for furnace oil. A large, nationally known marketing company has 700,000 gallons in storage at one refinery here. In settlement with the refiner for not taking the material out last season as first intended, that marketing company paid cash in advance, or over $30,000, as the gas oil was purchased on a basis of 4½ cents.

This is but one instance in this district alone of how marketers and distributers already have substantial purchases ahead of furnace oil. However, in the case of this marketer, this material may not come in direct competition with gas oil from refineries here until the market strengthens to a price nearly equal the cost of oil already on hand. For, in addition to the price of this gas oil the marketer has lost the interest on the money paid in advance.

Yet, this gas oil as well as other similar purchases of last season is known to be in storage here and will serve to check any important strengthening of the market here above the figure at which it was bought until it has been consumed in burners. Just when that time will be naturally depends on other factors which will be explained later.

Large Storage Programs

The second reason why furnace oil consumption will not be reflected readily in demand at refineries lies in the fact that marketing companies, distributers and other buyers with storage facilities have been filling up their tanks with material picked up on the spot market the past few weeks. When the furnace oil season opens they will be out of the market until their supply is exhausted or until refinery quotations again sag to a figure below the cost of their purchases.

Good gas oil suitable for most northern burners has been plentiful on the open market in this district from 2¾ to 3 cents. Substantial amounts have been purchased as low as 2½ cents, and, for no known reason except for storage purposes. These spot purchases have been reflected in some strengthening of the market until now, however, gas oil is not available below 3 cents except in a few special cases.

For the foregoing reasons it can be seen that some of next season's requirements have been provided for by material already in the hands of others than refiners, and that which wasn't bought during the period of advancing prices last season is going into storage at a cost below that offered by buyers on contracts. This also has served to keep many prospective buyers even from offering contracts.

While an exceptionally heavy demand for furnace oil or a long period of steady consumption would eliminate readily the material in storage now, refiners in this district are basing their chief hope for much stronger markets next season on other factors and thus are holding off making contracts at the present low offers.

Effect of Cracking

Without an outlet through burners or internal combustion engines, the only other demand for gas oil here, as in other refining districts, is for cracking or as a potential source of gasoline. This cracking demand naturally is dependent on the gasoline market together with the value of gas oil, as it replaces crude as charging stock, but the situation in North Louisiana and Arkansas is peculiar.

That is, in most sections of the country crude is so cheap that cracking stock, gas oil or distillate, is not worth very much for the latter purpose considering the present market for gasoline. In this district the picture is slightly different. Raw crude is not as readily available to independent refiners as elsewhere and the point in the gasoline market as compared with gas oil prices which would necessitate closing down of cracking units as unprofitable is lower.

With gasoline weak at 6¼ cents and gas oil cracking stock costing or worth 3 cents, as was the condition several weeks ago, it was to the advantage of refiners here to slow up cracking, as crude was costing from $1.22¼ to $1.35 a barrel (an average based on actual figures revealed in a survey.) Consequently cracking units were not run to capacity, one plant being shut down entirely for a month.

During that period gas oil softened a quarter to a half cent, due probably to the increased supply and lessened demand, and gasoline since has strengthened a quarter to a half cent, making cracking conditions more favorable. As a result, gas oil now is gaining in demand for cracking stock and as long as gasoline strengthens in proportion stronger and advancing gas oil prices can be expected.

Contrary to opinions of many, refiners here are optimistic on gasolines and feel that the coming season will witness favorable market conditions. In view of this, they are anticipating increased demand for gas oil as cracking stock which will be worth more to them than present offers for this product as furnace oil.

Not only this, but with cracking profitable, the supply of furnace oil available from this district will be considerably less next season than last. The Crystal Oil Refining Corp., until the past month having only skimming facilities and which formerly was a source of furnace oil supply, at present is out of the market and will be next autumn and winter. Installation this spring of two Jenkins high pressure cracking units is requiring the refinery's entire gas oil production. Other refineries also have increased cracking facilities which will tend to reduce the supply of furnace oil.

Refiners here have indicated that they will consider furnace oil contracts around 4¼ or 4½ cents for shipment next season, but with buyers slow to offer as high as 3¼ to 3½ cents, the situation here so far as future trading is concerned is at a standstill. One large North Louisiana refiner through its own distribution facilities in certain northern states is in a position to dispose of a substantial amount of furnace oil direct and is not dependent on cracking demand and calls from other buyers.

This refiner and others in this district also have jobbing connections and other buyers who make their purchases exclusively out of this district on the spot market or from month to month throughout the burner season regardless of the market price. As these refiners wish to keep these connections they would rather sell to them at a low spot market price next season than tie up their production with low contracts.

Specifications

The fact that several large jobbers and marketing companies fill their furnace oil requirements exclusively out of the North Louisiana-Arkansas district is due, according to these refiners, to certain characteristics of the product refined here which makes it particularly adaptable to burner use in northern states and the colder climate.

All gas oil in this district naturally possesses a low flash and meets zero cold tests, making it easily handled in cold climates. Refiners in most other refining districts can meet these requirements only at extra cost and many do not wish to take the extra trouble.

Operating principally on Smackover crude, which is known for its low flash running from 85 to 105 degrees, refiners are favored with a gas oil furnace oil with a flash ranging from 150 to 180 degrees, and a large patronage has been built up on these specifications alone. Due to the low gravity of the crude, the finished products, unless blended up, are lower in gravity than is customary, but it is the contention of refiners here that, if anything, this makes a better heat fuel. In heavier industrial burners and in larger office buildings of the northern cities, the raw Smackover crude itself is used. Refiners point out that while in the past burners in homes required a higher gravity oil than that refined here this situation rapidly is being changed so that lower gravity fuels can be used.

A survey of refiners here revealed that a representative product moved out of this district for furnace oil is a straw color gas oil having a gravity of 28 to 30 degrees, and open cup flash point of 150 degrees and a below zero cold test.

FURNACE OIL ARTICLES

In this issue The Oil and Gas Journal continues its discussion of the furnace oil market for the coming season. This discussion was started in the June 9 issue (pages 34 and 35) with articles by J. B. Waldo and L. M. Fanning. Mr. Waldo's article covered the market outlook in the Chicago area and that of Mr. Fanning, the eastern area centering in New York City.

In this issue Mr. Williams continues the discussion. His article is concerned primarily with manufacture of distillates for home burners in the North Louisiana and Arkansas area. Additional articles will appear in later issues.

OIL "JOKER" IN THE ARMS LIMITATION PACT

(Continued from Page 46)

may be some such outcome is not more unreasonable than the situation that has arisen to produce a famine of fuel oil in storage tanks owned by the United States on its own territory in the Philippine Islands.

It should be remembered that the oil industry of the United States is called upon to take care of the fuel oil supplies in any emergency that may confront the United States Navy. Also that the oil industry is in a better position to assert independence and to assist in the bringing about of practical conditions for supplying the Navy than anyone else. After all, it is the oil industry that has the duty thrust upon it for furnishing these supplies. Better than anyone else, it knows the particular difficulties it encounters and, although the Navy is always energetic and informed respecting its needs and is directed by the most capable naval experts, they cannot be expected to supply the technical information relating to the storage and transportation of petroleum in times of emergency as well as the oil industry itself, which has always been depended upon to take care of these necessities.

The Geneva Conference, in undertaking to reach some sort of agreement for further limitation of armament in vessels inferior to the battleship, might very well hit upon fuel oil as a part of its plan. That, in fact, would be more proper in respect to these smaller craft than was the action taken in the restriction against any increase in storage facilities for fuel oil in the Philippines.

British Bunkering Ports

This is so because the far-flung British Empire possesses infinitely more oil storage facilities throughout the world than does the United States. As against Pearl Harbor, Cavite, Olongapo and Samoa as the outlying bases from which the American Navy may procure fuel oil, Great Britain has 25 outlying bases in which vast quantities of oil are carried, both for naval and commercial purposes. When these vast quantities are considered, it will be seen how utterly insignificant are the preparations of the United States for any naval activity even in its own possessions in the Far East. For instance, at Singapore, the British have actual and projected storage facilities for 5,500,000 bbls. of fuel oil; in Trincomali, Ceylon, they have projected nearly 1,500,000-bbl. storage capacity, and in Colombo they have about 500,000 bbls., with something like 170,000 bbls. of commercial storage. In Rangoon, Burma, they have projected storage of about 1,000,000 bbls., with 750,000 bbls. actual storage and about 150,000 bbls. of commercial storage.

At Malta they have more than 500,000 bbls. naval fuel oil storage with 100,000 bbls. commercial storage. At Port Said they have over 100,000 bbls. of naval storage and 330,000 bbls. of commercial storage. There is a large amount of naval oil storage at Gibraltar, the amount of which has never been made known, with something like 50,000 bbls. commercial storage. At Suez there is also naval oil storage, the amount of which is unknown, with something like 100,000 bbls. commercial storage. At Port Sudan (Anglo-Egyptian Sudan) there are nearly 200,000 bbls. of naval storage and something like 80,000 bbls. of commercial storage.

Storage in Pacific

In the Indian and Pacific Oceans the amounts of fuel stored for the British Navy are enormous. In addition to those above referred to, there are nearly 200,000 bbls. at Aden, Arabia, with about half that amount of commercial storage. At Bombay there is no naval storage but over 100,000 bbls. of commercial storage. They could put oil storage in Port Louis, Island of Mauritius, but they have none there at present. This same condition applies to King George Sound, West Australia, to Weihaiwei, China, to St. Helena, Port Castries, Island of St. Lucia, and to Halifax, although in the last named place there is about 200,000 bbls. of commercial storage.

It will be seen that many of these ports have no necessity, or only trifling need, for any commercial storage, yet a vast supply of oil is maintained for naval storage. This is the case at Kingston, Jamaica; Freetown, Sierra Leone, B. W. A., where there is about 125,000 bbls. storage, Port Stanley, Falkland Islands, the amount not known; Esquimalt, B. C., a small quantity.

At Auckland, New Zealand, there is storage capacity for 70,000 bbls. for the British Navy, at Sydney, Australia, about 150,000 bbls. naval storage and 250,000 bbls. commercial storage; at Simonstown, 80,000 bbls. for naval purposes and 125,000 bbls. for commercial purposes at Cape Town; at Bermuda there are over 100,000 bbls. naval storage and 50,000 bbls. commercial storage. These figures are compared with our own naval storage of about 110,000 bbls. in Cavite and Olongapo and 250,000 bbls. for commercial purposes, with nothing available from American sources short of 7,000 miles.

Of course the storage, both for the Navy and for commercial purposes at ports of the United States means little because tanks at these ports could readily be refilled from our own oil fields. Such storage is a little more than sufficient for current needs of the Navy and commercial needs of the merchant marine ond for these purposes they are regarded as ample in times of peace at least.

American Fuel Storage

The United States now possesses storage for fuel oil amounting to about 12,000,000 bbls. capacity, much of which was provided by fuel oil exchanged for storage under the Doheny contracts. But amid all the discussion that has taken place respecting oil reserves for the Navy in times of emergency, Congress has wholly ignored, and no one else seems to be pressing, the projected plan made by the Navy several years ago by which something like 50,000,000 bbls. of fuel oil might be stored for emergencies for the Navy. The Oil and Gas Journal published this estimate prior to any official announcement of the quantity of storage contemplated by naval authorities as adequate for emergency purposes. Later, when a congressional committee was investigating the oil industry, it was developed by an official paper submitted to the committee that these 50,000,000 bbls. of storage represented the ambition of naval authorities to be prepared to meet reasonable emergencies.

When it is considered that the Navy in peace times, merely for purposes of necessary maneuvers to keep vessels and crews in trim in the practical operation of naval vessels, require 7,000,000 bbls. of fuel oil annually, it is seen that 50,000,000 bbls. for war purposes would not be excessive. Such a supply probably would provide for not more than a year and a half of the needs of the Navy. Its presence in tanks at convenient ports would relieve the Navy of great responsibility and allow sufficient time to replace any depletion of the supply.

Admiral Sims' Warning

It should be remembered that the entire battle line of the American Navy has now been placed on an oil-burning instead of a coal-burning basis and that an oil supply for the merchant marine in time of war is almost as important as is a supply for the Navy itself, because in an emergency the merchant marine would become an auxiliary of the Navy. For this reason there seems to be just as much importance in looking after the needs of the merchant marine as for any other branch of the service, because fuel oil is taking the place of coal in our merchant ships.

Recently Admiral William S. Sims has promoted a controversy in respect to the deficiencies of the American Navy in its oil supplies.

Admiral Sims has pointed out that Great Britain has established great stores of oil at her bases all over the world, and that Japan has accumulated vast reserves of this munition. He comments upon the superiority of oil-burning ships over coal-burning vessels, which is so great that any navy, or even merchant marine, in time of war would be fatally crippled without an oil supply.

Just what can be done to advance the interests of the American Navy in the acquisition of sufficient oil supplies is a question that will have to be dealt with both by the executive and legislative branches of the Government, and that may take a long time. However, what took place in 1921 at the Conference for the Limitation of Armament at Washington, D. C., makes it highly expedient that the Geneva Naval Limitation Conference should be watched by everyone whose duty it is to see that there is no further crippling of the ability of the United States Navy to supply itself with fuel oil and, in fact, if there is any rule of reason looking to such limitation on a basis of equality, fuel oil supplies for American naval vessels in foreign waters should be extended far beyond that which now exists.

It was the dream of Admiral Colby M. Chester to supply the fuel oil needs of the American Navy with Mesopotamian oil to be delivered at a location convenient to the Mediterranean end of the Suez Canal.

Now, looming above all other considerations, is the need for watchfulness to quickly thwart any surprise movement of the Geneva Conference so that the present oil facilities of the American Navy may not be further curtailed, to add to the embarrassment occasioned by the restriction placed on storage tanks in the Philippine Islands. To guard against such a contingency there could be no better plan than to have the American oil industry represented on the body of experts who represent the United States.

NEW NATURAL GAS CORPORATION TO OPERATE FROM WASKOM FIELD

By Neil W Illiams

SHREVEPORT, La., June 13.—Organization of another major natural gas producing, transporting and distributing system to be operated by the newly formed Dixie Gas & Utilities Co. and the Dixie Pipe Line Co., affiliated interests, was announced by local representatives Monday following consummation of the negotiations in New York.

The former company will be the producing and distributing company and the latter the transporting medium. Both have been chartered under the laws of Delaware. Headquarters will be maintained in Shreveport.

The project is backed by the Seagraves and Moody interests of Houston and Galveston, Tex., who have acquired an extensive gas acreage and production in the Waskom gas field of eastern and northwestern Louisiana, and will lay a trunk gas line to Houston and Port Arthur, Tex., and will distribute gas along the line as well as to the refineries at Port Arthur and Beaumont.

B. A. Hardy of Shreveport, representative of the Thigpen & Herold holdings acquired by the Dixie, will be vice president and general manager of the Dixie Gas & Utilities Co. O. R. Seagraves is president of the Dixie Pipe Line Co. and S. C. Goddard of New York is vice president and secretary. Directors include Mr. Hardy, W. L. Moody, Jr., W. L. Moody, 3d, J. A. Elkins, W. D. Haden, W. D. Haden of New York, James Miller of Pittsburgh, Pa., and Harry Smith of Houston.

Moody and Seagraves have as a nucleus the Marshall Natural Gas Co., the distributing company at Marshall, Tex., a half interest in the Reserve Natural Gas Co., a gas transporting company, and the producing holdings of Thigpen & Herold, and properties of Albert Glassell and others, all of which have been required in the past few weeks.

The Reserve Natural Gas Co. formerly was owned by the Arkansas Natural Gas Co., The Texas Company and the Southwestern Gas & Electric Co., the latter the distributing company at Shreveport. Seagraves and Moody interests purchased the entire ownership of The Texas Company in the Reserve and in the Marshall Natural Gas Co. for $1,250,000, and with the Arkansas Natural Gas Co. brought out the Southwestern Gas & Electric Co.

The Reserve Natural Gas Co. has lines from the Waskom Field, the gas production in the Pine Island Field of Caddo Parish, the Elm Grove Field of Bossier Parish and the Webster Parish Field, in addition to holdings in the Waskom Field for the Dixie companies.

Through purchase of the Thigpen & Herold interests, which include the State Line Oil & Gas Co., the Muslow Oil Co. and the Waskom Drilling Co. and other acquisitions, Seagraves and Moody have 10,500 acres of gas rights in proven and semiproven territory including 26 producing wells. This represents a total open flow capacity of 325,000,000 feet. The Thigpen & Herold transaction involved a cash consideration of $450,000 with representation of these interests in the new Dixie companies.

A new producing or operating company may be organized to operate this end of the production holdings as a subsidiary of the Dixie Gas & Utilities Co. Pending this or taking over of the direct development by Dixie, which has not yet obtained a license to operate here, the properties are being drilled by Mr. Hardy as trustee.

The Dixie Pipe Line Co. will start surveys at once for a 20-inch gas line from the Waskom Field to near Livingston, Tex., 80 miles northeast of Houston. The line will branch into two 16 inch lines, one to Houston and the other to Port Arthur. A booster station to cost $1,000,000 will be built at Waskom, and another at Livingston.

The company plans to build a line from the new Carterville gas field in northern Bossier Parish, Louisiana, 6 miles, to connect with the main line of the Reserve Natural Gas Co. from the Webster Parish Field. This will provide an outlet for the gas in that field, yet untouched, and additional reserves for the Dixie. Both the Magnolia Gas Co. and the Dixie have been competing in the Carterville Field for gas contracts.

Both Mr. Seagraves and Mr. Moody hold a large block of stock in the Houston Gulf Gas Co., the distributing company at Houston, and its affiliated interests, and through the Dixie Pipe Line Co. connections will be made to provide Houston with additional gas reserves. A 30 per cent ownership in the Houston Gulf Gas Co. recently was acquired by the United Gas & Electric Co., controlled by the Empire Power Co.

In addition to distributing gas in Marshall, Tex., through the Marshall Natural Gas Co., acquired from The Texas Company, a franchise has been obtained to distribute in Orange, Tex., and applications for franchises at Lufkin, Nacogdoches, Jacksonville and other cities along the line have been made.

The transaction also brings together two major systems, as the Arkansas Natural Gas Co., the other owner of the Reserve Natural Gas Co., has a main line running northward from the Pine Island Field through important cities to Little Rock, Ark. However, the Arkansas and the Dixie will have no connection other than the 50-50 ownership in the Reserve.

NORTH AND WEST TEXAS

(Continued from Page 49)

don, about 3 miles south of Anson, progressed very little during the week. Total depth of the hole by steel line measurement is 2,499 feet, and at latest report it was cleaning out with about 2,000 feet of oil in the hole.

In Winkler County, Llano Oil Co.'s No. 1 Scarborough near the New Mexico line, had finished rerunning the 8-inch at latest report and was ready to resume drilling at 3,095 feet.

Callahan Deep Sand

The opening of the first deep sand pool

in Callahan County and good extensions to production in Cooke County were the outstanding events in North Central Texas this week.

In Callahan County, Empire Gas & Fuel Co.'s No. 1 Johnson, in Section 146, G. H. & H. Survey, was estimated good for 25,000,000 feet of gas and was spraying 25 to 30 bbls. of oil at 4,145 feet. This well is located about 3 miles from the south line and about 9 miles from the west line of the county. It was formerly completed for 9,000,000 feet of gas and when slightly deepened the gas increased and the well started spraying oil.

Cooke County now has 104 oil wells and 2 gas wells and is getting its second pipe line. Humble Pipe Line Co. has been taking most of the Cooke County production through a 4-inch line from Nocona to the Bulcher Field and a 2-inch from there to Muenster. The Sinclair Pipe Line Co. is laying a 6-inch line from Nocona to the Bulcher Field and a 4-inch from there to Muenster, and is building a pump station at both places. Humble Pipe Line Co. is also building a pump station on the Kleiss farm at Muenster and Roxana Petroleum Corp. is going to build a loading rack at the same town in order to ship its production on the Walterscheid farm.

The Pure Oil Co.'s No. 2 Embry, in the SE cor. of their 80-acre lease southwest of the main Hooser Pool and northwest of the Chapman & Lanier Pool, found a new sand last week at 1,404-08 feet, swabbing 147 bbls. in 7 hours. This is the fourth sand found in the Bulcher area. Chapman & Lanier's No. 3 Montgomery, one location south of No. 1, made 110 bbls. from sand at 1,307-09 feet, total depth 1,321 feet, extending production of that pool one location south.

Ed Ruwaldt's No. 1 Koelzer in the Muenster townsite, north of the pool on a 1.13-acre tract, appears to have extended production 1,360 feet in that direction. It found a sand at 1,658-61 feet and was cementing 6-inch to test it with excellent prospects of making a well.

WEST TEXAS COMPLETIONS

Crane County

Church & Weekley's No. 2 University found sand at 2,834-2,952 feet and flowed 560 bbls. after a 170-quart shot at 2,844-2,952 feet. Eastland Oil Co.'s No. 8 Collett, had sand at 2,845-2,950 feet and was shot with 90 quarts at 2,887-2,950 feet and made 3,850 bbls. initially after shot.

Howard County

F. H. E. Oil Co.'s No. 1 John Roberts pumped 40 bbls. from sand at 1,844-64 feet.

Mitchell County

Magnolia Petroleum Co.'s No. 8 C. M. Adams, was shot with 300 quarts at 2,940-3,064 feet and swabbed 70 bbls.

Nolan County

Thomas & Reynolds' No. 1 Allen was a failure at 3,511 feet.

Pecos County

Mid-Kansas Oil & Gas Co. and Transcontinental Oil Co.'s No. 1 Smith-Taylor, flowed 3,577 bbls. from sand at 1,185-1,271 feet. Humble Oil & Refining Co. and Kirby Oil Co.'s No. 1 J. F. McElroy was a duster at 2,015 feet.

Taylor County

No results were had from Midwest Exploration Co.'s No. 1 Toombes at 2,757 feet.

Upton County

Humble Oil & Refining Co.'s No. 5 Ricker found sand at 2,155-2,268 feet and flowed 830 bbls. in 23 hours from pay at 2,255 feet. Prairie Oil & Gas Co.'s No. 2 Allie Lane flowed 50 bbls. by heads from sand at 1,965-85 feet. Sartain & Davis' No. 1 Bull was a duster at 3,523 feet. The Texas Company's No. 1 Perry found top of pay at 1,965 feet and at 2,041 feet flowed 352 bbls. June 7, 250 bbls. June 8, 300 bbls. June 9. Tidal Oil Co.'s No. 1 Hughes flowed 300 bbls. at 2,296-3,301 feet. Texas Pacific Coal & Oil Co.'s No. 8 Lane-A had sand at 1,982-2,031 feet and is flowing and pumping 700 bbls. through 3-inch tubing; No. 9 was flowing and pumping 150 bbls. from sand at 2,040-70 feet.

North Central Texas Completions

Archer County

Atlantic Oil Producing Co.'s No. 2 Wilson-D made 52 bbls. at 1,534-44 feet; No. 3 made 162 bbls. at 1,530-44 feet. Graham and others' No. 1 Edwards was a failure at 1,587 feet. So was Jeffers & Jeffers' No. 1 Jackson at 1,600 feet. Ray & Massie's No. 1 Wilson-A was also dry at 1,585 feet. Bridwell & Heydrick's No. 1 Sam Cowan was a duster at 1,506 feet. Consolidated Oil Co.'s No. 1 Abercrombie & Taylor had sand at 1,378-84 feet and made 25 bbls. Gwynn & Roxana Petroleum Corp.'s No. 1 Ward pumped 68 bbls. at 930-37 feet. Pandem Oil Corp.'s No. 1 Thomas-B, failed to produce at 1,400 feet. Roxana Petroleum Corp. and Sun Oil Co.'s No. 1 Farmer was also a failure at 1,604 feet.

Brown County

Anderson's No. 1 Bowden was dry and abandoned at 1,402 feet. Barbara Oil Co.'s No. 6 Willis was dry and plugged at 1,390 feet. Charles Bell and others' No. 1 Garnett was a duster at 1,710 feet. J. K. Hughes' No. 14 Shore found sand at 1,259-79 feet and made 600 bbls. after a 3-quart shot; No. 21 Shore made 600 bbls. from sand at 1,293-1,313 feet. Humphrey Brothers' No. 1 Bell was a failure at 2,275 feet. McKanna and others' No. 15 Shore made 300 bbls. from sand at 1,304-27 feet; No. 16 found sand at 1,327-29 feet and made 200 bbls. Selby Oil & Gas Co.'s No. 2 Ellis had sand at 1,307-27 feet and made 383 bbls. Sinclair Oil & Gas Co.'s No. 4 Shore flowed 558 bbls. from sand at 1,304-17 feet; No. 7 made 600 bbls. at 1,292-1,311 feet. The Texas Company's No. 2 Byler flowed 135 bbls. at 1,281-1,302 feet; No. 55 Lowe made 100 bbls. at 1,248-53 feet. Jack Ward and others' No. 1 Byler made 50 bbls. at 1,306-22 feet. Wentz Oil Corp.'s No. 7 Shore had sand at 1,329-35 feet and made 75 bbls.; No. 18 also had sand at 1,313-31 feet and made 165 bbls.; No. 19 found sand at 1,312-29 feet and made 250 bbls. Henshaw and others' No. 1 Caldwell was a duster at 881 feet. Ryan and others' No. 3 Brooks made 1,500,000 feet of gas at 851-55 feet.

Clay County

Lone Star Gas Co.'s No. 15 Miller made 260,000 feet of gas at 1,518-1,605 feet. Seabury and others' No. 1 Cozart was temporarily abandoned at 1,000 feet. Stump & Co.'s No. 2 Boddy was a failure at 1,301 feet.

Coleman County

Brown & Co.'s No. 2 Powell was a duster at 1,508 feet.

Cooke County

Chapman & Lanier's No. 3 Montgomery found sand at 1,292-97 feet and made 110 bbls. initially from oil sand at 1,307-09 feet, total depth 1,321 feet. Stroube & Stroube's No. 3 Koelzer-A, flowing by air 340 bbls. from oil sand at 1,621-40½ feet. Sun Oil Co.'s No. 1 Hooker made 110 bbls. initially from sand at 1,721-50 feet, total depth 1,755 feet.

Eastland County

Lewis and others' No. 1 Holcomb made 3,000,000 feet of gas at 1,583-84 feet.

Jack County

Brentmoor, Inc.'s No. 1 Roach found sand at 514-26 feet and made 2 bbls. of oil.

Montague County

The Texas Company's No. 5-B Gist made 45 bbls. at 881-908 feet. Woods, Benton and Lest & McCall's No. 1 Cunningham made 15 bbls. at 939-44 feet. Dale Oil Corp.'s No. 1 Adams was a failure at 2,402 feet.

Shackelford County

Gwinnup and others' No. 1-63 Green was a duster at 1,745 feet. Lee & Dingee's No. 1-B Myer made 70 bbls. at 1,030-34 feet. Milham Corp.'s No. 4 Moore flowed 224 bbls. of oil and 75 bbls. of water from sand at 4,350-60 feet. Roeser & Pendleton's No. 2-25 Reynolds made 20 bbls. of oil at 1,231-3 9feet. Rose and others' No. 4 Moberly found sand at 1,362-72 feet and made 110 bbls.

Throckmorton County

Cranfill & Reynolds' No. 2 Lee was dry at 633 feet. So was Hickman & Heydrick's No. 5 Upsher County chool land, at 1,335 feet.

Wichita County

Magnolia Petroleum Co.'s No. 133 Reilly flowed 15 bbls. at 1,567-74 feet; No. 45 Staley Beach made 6 bbls. at 1,206-13 feet. Wolfe & Son's No. 2 Nitschke was a failure at 1,850 feet. Archer Oil Co. and others' No. 1 Barten was a duster at 1,825 feet. So was Beaver Drilling Co.'s No. 1 Chilton at 1,831 feet. Consolidated Oil Co. and Apple & Brandeberry's No. 2 Ancell made 145 bbls. at 1,722-25 feet. Panhandle Refining Co.'s No. 1 Daume made 2 bbls. of oil and 15 bbls. of water at 1,827-29 feet. Red River Oil Co.'s No. 5 By Water had sand at 1,790-98 feet and made 80 bbls. Shappell Oil Co.'s No. 8 Kemp & Kempner found sand at 1,624-30 feet and made 22 bbls. The Texas Company and others' No. 3 Waggoner found 24 bbls. of oil and 29 bbls. water at 1,266-84 feet; No. 329 was a failure at 2,252 feet.

Wilbarger County

Humble Oil & Refining Co.'s No. 1-R Waggoner was dry at 2,165 feet. Murchison Oil Co.'s No. 2 Waggoner-B made 22 bbls. at 2,002-19 feet. Phillips Petroleum Co.'s No. 16-A Waggoner had sand at 2,563-93 feet and made 100 bbls.; No. 7-HH flowed 155 bbls. at 2,556-58 feet; No. 2-QQ had no results at 2,512 feet; No. 6-WW also failed to produce at 2,726 feet.

Young County

Boller and others' No. 3 Gragg found sands at 743-58 feet and 760-75 feet and made 80 bbls. Madden & Hunt's No. 1 Perkins failed to produce at 793 feet. J. J. Moran's No. 1 Gragg had sand at 746-803 feet and made 20 bbls. of oil and 10 bbls. of salt water. Panhandle Refining Co.'s No. 8 Mathews made 15 bbls. of oil from sand at 722-38 feet. E. L. Smith's No. 1 Thomas was a duster at 902 feet. Shonquist Drilling Co.'s No. 1 Burnett was shot with 60 quarts at 3,904-21 feet and made 88 bbls.

Purchases Reported

An undeveloped lease several hundred feet north and east of production in the Muenster Townsite Pool of western Cooke County was purchased by J. B. Sowell of Dallas from W. M. Lange of Gainesville for $1,000 an a acre and a one-sixteenth overriding royalty. The lease contains 5.2 acres, and is located in Block 90 of the townsite.

Two production sales were made in Shackelford County during the past week. Lee & Dingee sold their 112-acre tract in Section 1, G. H. & H. Survey, northwest of Albany, on which they completed a 70-bbl. well last week at 1,030-34 feet. The tract has four producing wells and was sold to the Wichita Production Co. for a reported consideration of $50,000.

Bridwell & Heydrick purchased a 40-acre lease out of Section 9, Block 11, T. & P. Survey, about half a mile north of the Lee & Dingee No. 1 Meyers-B, from L. C. Kelvey for $60 an acre.

The Gillespie estate of Pittsburgh, Pa., sold its holdings in Shackelford and Brown Counties, containing about 50 bbls. of production, to Gilmam & McMurray for a reported consideration of $60,000.

LITTLE ACTIVITY IN THE OKLAHOMA MARKET

(Continued from Page 36)

Rocky Mountains	5,204	4,835	369
California	13,498	10,446	3,052
United States	52,379	45,767	6,612
Texas Gulf Coast	6,473	4,835	1,638
Louisiana Gulf Coast	3,500	3,898	*398
Mid-Continent	5,595	4,657	938

*Decrease.

The table shows that on May 1 of this year approximately 35,000,000 bbls., or 70 per cent of the total of 52,379,000 bbls. in storage, was in the hands of refiners located along the East Coast, Gulf Coast and West Coast. When comparison is made with stocks on the same date of last year the figures show that these three same coastal areas have 92 per cent of the total increase in stocks of 6,612,000.

These data reflect again the dominance of the coastal areas in regard to gasoline, a situation brought about by their strategic location in regard to both crude supply and markets for refined products. The stocks in the coastal areas are offered in explanation of the fact that very little gasoline business is being placed with the interior refiners.

Coastal Operations

Coastal refinery operations also are becoming more important as a direct factor in the domestic market. This is a fact which Mid-Continent and other interior refiners often overlook in gauging their own market. Facilities for combination water and rail movement of gasolines have been perfected to the point where the coastal refiners can often move their products over longer distances at lower transportation costs than the interior refiners who are dependent entirely on rail movement.

As summarized by one market student, developments of the past two weeks in the Mid-Continent area constitute another example of the futility of endeavoring to gauge by local conditions the gasoline tank car price for a product which is essentially national in its marketing scope. In the final analysis this means that Mid-Continent refinery situation cannot improve until justified by general conditions.

Gasolines and Naphtha

The greatest interest in the refinery gasoline market during the past week centered around the 58-60 U. S. Motor grade. With no export buying and the domestic demand for the higher gravities practically confined to the 400 endpoint grade, the output of most refiners is now largely confined to the U. S. Motor grade. The moving price for several days has been from 6⅝ to 6¾ cents.

Among the higher gravities the 400 endpoint gasoline was the most active. Refiners who are willing to sell at 7 cents are not having difficulty in moving their output. Several refiners take the position that they would rather sell the U. S. Motor at the prevailing price and are not active in the 400 endpoint market. The 390 and 375 endpoint gasolines were available at prices one-eighth to one-quarter cent above the 400 endpoint grade.

The three or four refiners offering naphtha were asking 6¼ and 6⅜ cents for 450 endpoint material.

Kerosenes and Distillates

Kerosenes weakened an additional one-eighth cent during the week. The 41-43 grade was available at a low of 4 cents with that price shaded for delivery over the month. With the market expected to continue inactive for several weeks it is expected that refiners will give more attention to the distillate market. Refiners report numerous inquiries for distillates with some spot business being placed. Occasional sales of the 38-40 grade are reported at 3⅛ cents, although the bulk of the movement is at 3¼ cents. Refiners in a position to furnish distillates with a flash of 175 or under are getting the bulk of the business.

Natural Gasolines

As previously explained the A and B grades are lower in price. The C grade due to the lessened output was fairly firm. A few manufacturers were quoting all grades at 5 cents the first of the week. The general market on Tuesday, however, was 4¾ to 5 cents for the B and C grades and 5 to 5⅛ cents for the A grades.

Fuel Oils and Gas Oils

There were practically no changes in fuel oil and gas oil prices during the week. Refiners who lowered their prices slightly the previous week were not giving additional concessions. The new demand was not active, but many of the refiners are well taken care of on orders over the balance of the month. Buyers are willing to pay 2⅝ for 32-36 gas oil, but sellers asking 2¾ to 3 cents are generally running their gas oil to storage.

Lubricating Oils and Wax

The sales manager of a refinery with a lub oil plant generally states that his movement of lubs is better than his movement of gasoline. Many jobbers this year have been "pushing" their lub sales to consumers and this has been reflected in the demand at refineries. No price changes were reported during the week in either lubs or wax.

Late Fields

(Continued from Page 47)

capacity with a strong pressure and is spraying oil. An effort will be made to extinguish the flames with steam and boilers are being assembled.

EAST CENTRAL TEXAS

E. L. Smith and others' deep test, No. 1 Stuberanch, near Mexia, Limestone County, Texas, will be shut in as a gas well. The section of drill stem that was hung in the hole has been recovered. Heaving shale has prevented the coring of the sand. It is said the well has cost in the neighborhood of $100,000.

LOUISIANA-ARKANSAS

SHREVEPORT, La., June 14.—The Magnolia Petroleum Co.'s No. 1 Dodson, Section 15-23-12, in the wildcat Carterville area of northern Bossier Parish, has been bailed in and is flowing at an estimated rate of 30,000,000 feet of gas daily from sand at 3,084-87 feet. It has been shut in.

In the Pleasant Hill Field of Sabine Parish, the Arkansas Fuel Oil Co.'s No. 1 Rembert, Section 5-9-12, is swabbing at the rate of 47 to 50 bbls. of oil daily from a total depth of 3,312 feet. The top of the sand is 3,227 feet. Arkansas Fuel Oil Co.'s No. 1 Moore, Section 32-10-12, swabbed 32 bbls. of oil in 18 hours. Both wells probably will make small pumpers. The total depth of the latter is 3,278 feet. In the same field, the Louisiana Oil Refining Corp.'s No. 1 Logan, Section 28-10-12, is flowing 60 bbls. daily.

WEST TEXAS

FORT WORTH, Tex., June 14.—Landreth Production Co.'s No. 2 State on Crane County, offsetting Gulf Production Co.'s No. 12 McElroy, topped pay at 2,810 feet and flowed 1,970 bbls. in 24 hours, ending at 6 a. m. Monday at 2,895 feet and at 6 o'clock Monday afternoon was flowing 77 bbls. an hour. The Gulf offset which flowed better than 4,000 bbls. is 2,940 feet deep and surface elevations are about equal. There are 11 wells along this strip drilling below 2,000 feet in addition to six wells making oil.

In Cooke County Ruwaldt's north extension to Muenster Townsite Pool swabbed 200 bbls. Monday at 1,656-81 feet. Oil Operators Trust Co.'s No. 5 Ben Luke, east extension of same pool, had hole full of oil at 1,624-54 feet but pipe was damaged when shot with 10 quarts.

WEST TEXAS OIL BUREAU

CISCO, Texas., June 13.—The next convention of the West Texas Chamber of Commerce will be held June 11, 12 and 13 at Fort Worth. The directors went on record as favoring creation of an oil and gas bureau within the chamber and set aside $10,000 for the first year's operation.

WILDCAT OPERATIONS IN WEST TEXAS

(Continued from Page 47)

CONCHO COUNTY

Harry Adams et al's No. 1 Price, C SW Sec. 78, Blk. 71, Alex Gregg Sur. — Shut down 1,040 ft.

Arkansas Fuel Co.'s No. 1 Hartgrove, SW cor. NW Sec. 49, Blk. 70, H. & T. C. Sur., 12 mi. E of Paintrock — 1,000,000 ft. gas 1,100-10 ft.; 4,500,000 ft. gas 1,142-47 ft.; small show oil in sandy lime 2,165 ft.; show oil 2,454-80 ft.; show oil and 200,000 ft. gas 2,494-2,512 ft.; bailed 8 bbls.; total depth 3,236 ft.; plugged back to gas sand.

Associated Oil Co.'s No. 1 Sam Waring, Sec. 2,035, J. W. Godhardt Sur. — Rebuilding rig; 500 ft.; rigging up.

The Exploration Co.'s No. 1 Hartgrove, Blk. 240, J. Schouch Sur. — Shut down 1,930 ft.

CROCKETT COUNTY

Anchor Oil Co. (Cumberland) No. 1 Couch, C NE Sec. 18, Blk. QR, D. & S. E. T. R. R. Sur. — Shut down 3,075 ft.

V. T. Bolin & Co.'s No. 1 P. C. Coates, NW cor. SW Sec. 4, Blk. 2, I. & G. N. Sur. — Shut down 2,110 ft.

J. K. Hughes' No. 2-B Powell, Sec. 63, E. L. & R. R. Sur. — Fishing for 18 joints 8-in.; total depth 2,535 ft.; shut down.

William Shaffer et al's No. 1 University, C SE SE Sec. 9, Blk. 47, University Sur., elev. 2,344 ft. — Total depth 2,344 ft.; plugged back to 2,208 ft.; shot 10 qts. 2,170-95 ft.; shut down.

William Schaffer et al's No. 2 University, 1,350 ft. N and 2,610 ft. E of SW cor. Sec. 9, Blk. 47, Univer. Land. — Top salt 1,060 ft.; drilling 1,400 ft.

W. W. Donnelly, Young, Logan & Hult's No. 1 Pierce, C SW Sec. 150, Blk. O, G. H. & S. A. Sur., elev. 2,105 ft. — Rainbow show 454 and 540 ft.; shut down for 10-in. 1,375 ft.

P. H. Williams' No. 1 L. P. Powell, NE cor. Sec. 53, Blk. BB — Top salt 1,052 ft.; top lime 2,466 ft.; flowed 341 bbls. 2,575-90 ft., 33.5 gravity; 1,640 bbls. May 31 to June 5.

Word Oil Co.'s No. 1 Schneeman, N and W SE cor. Sec. 57, Blk. BB, G. C. & S. F. Sur., elev. 2,679 ft. — Top salt 1,035 ft.; sulphur water 2,490 ft.; total depth 2,575 ft.; trying to swedge pipe.

Young & Donnelly's No. 1 J. M. Shannon, Sec. 9, Blk. 8, D. & S. E. Sur. — Spudded and shut down.

CULBERSON COUNTY

James H. Gardner et al's No. 1 Radford, C SE Sec. 29, Blk. 62, Public School Land Sur. — Shut down 450 ft.

ECTOR COUNTY

J. S. Cosden, Inc., et al's No. 2 Connell-A, NW cor. NE Sec. 13, B-16, School Land, elev. 2,844 ft. — Top salt 870 ft.; drilling 3,220 ft.

J. S. Cosden et al's No. 3 G. W. Connell-A — Top salt 863 ft.; drilling 3,010 ft.

FISHER COUNTY

Barber Oil Co.'s (was Mason Oil Co.'s) No. 1 W. A. Cross. — Hole full salt water 2,350-70 ft.; drilling 2,880 ft.

Zoch & McCamey and Marland Oil Co.'s No. 1 Lanius A (was Danciger O. & R. Co.'s No. 1 Lanius), NE cor. SE Sec. 15, Blk. Y, T. & P. Sur. — Set 5-in. 3,661 ft.; hole full water 3,770 ft.; shut down 3,800 ft.

Ideal Oil Co.'s No. 1 Jameson, C SE Sec. 111, Blk. 1, H. & T. C. Sur. — Hole full salt water 2,345-2,520 ft.; shut down 2,707 feet for water.

Marland Oil Co. and Texon's No. 1 McCall, Sec. 108, Blk. 3, H. & T. C. Sur. — Rig.

Marland Oil Co. and Vacuum Oil Co.'s No. 1 J. H. R. Lagow, Sec. 3, Blk. 22, T. & P. Sur. — Set 10-in. 2,076 ft.; drilling 2,465 ft.

Miley Oil Corp. and Marland Oil Co.'s No. 1 W. W. Ammons, Sec. 198, Blk. 3, H. & T. C. Sur. — Running 15-in. 725 ft.

R. W. Raney's No. 2 Maberry, Sec. 56, Blk. 1, T. & P. Sur. — Shut down for orders 2,725 ft.

Sinclair Oil & Gas Co.'s (was Bourdon Royalty Co.'s) No. 1 J. A. Danise, Sec. 6, Blk. K, T. & P. Sur. — Shut down for casing 565 ft.

Stearns & Streeter's No. 1 W. A. Howell, N and E SW cor. NE Sec. 12, Blk. 23, T. & P. Sur. — Set 6-in. 3,565 ft.; drilling 3,715 ft.

The Texas Company's No. 1 D. S. Stevens, C SW SE SE Sec. 79, Blk. 1, H. & T. C. Sur. — Drilling 1,325 ft.

FOARD COUNTY

Fain-McGaha Oil Corp.'s No. 1 Mathews — Sandy lime 855-60 ft.; 1,000,000 ft. gas; underreaming 12-in. 935 ft.

Humble O. & R. and Navarro Oil Co.'s No. 1 L. McAdams, C S ½ Sec. 27, Blk. L, S. P. Sur. — Hole full water 2,560 ft.; drilling 3,005 ft.

The Texas Company's No. 1 Watkins — Rigging up standard tools.

GAINES COUNTY

Westheimer & Daube's No. 1 Birge & Forbes Land Co., Sec. 308, Terrell County School Land — Rotary; drilling 2,400 ft.

GARZA COUNTY

Emerald Oil Co.'s No. 1 D. Boren, NW cor. NE Sec. 137, Blk. 5, H. & G. N. Sur. — Small show oil in gray lime 1,884-1,902 ft.; shut down 2,600 ft.

Pandem Oil Co.'s No. 1 Justice, SW cor. NW Sec. 2, Blk. 6, H. & G. N. Sur. — Rigging cable tools.

GLASSCOCK COUNTY

California Co.'s No. 1 W. B. Currie, Sec. 215, Blk. 29 — Rigging up machine.

Green et al's No. 1 F. G. Oxsheer, Sec. 6, Blk. 34, T. & P. Sur. — Shut down 200 ft.

Landreth Producing Corp.'s No. 1 A. L. Houston — Building rig.

World Oil Co. and J. S. Meriwether's No. 1 L. S. McDowell, C SW Sec. 43, Blk. 34, Twp. 2-S, T. & P. Sur., elev. 2,553 ft. — Drilling 640 ft.

R. P. Penn et al's No. 1 W. P. Edwards, C SE Sec. 11, Blk. 34, Twp. 2-S, T. & P. Sur., elev. 2,501 ft. — Slight show oil 905 ft. in brown sand; top salt 1,295 ft.; shut down 2,250 ft.

Sid Richardson et al's No. 1 Burns, NE cor. SW Sec. 183, Blk. 29 — Shut down for water 820 ft.

HOWARD COUNTY

Bowers et al's No. 1 Chester Jones, C SW Sec. 32, Blk. 27, T. & P. (3,200-ft. test) — Shut down 500 ft.

Fred Carey et al's No. 2 G. O. Chalk, SE NW Sec. 124, Blk. 29 — Shut down 1,140 ft.

W. W. Donnelly et al's No. 1 Martin, SE cor. Sec. 41, Blk. 33, T-2-N, T. & P. Sur. — Drilling 1,680 ft.

Francis & Brunson's No. 1 J. W. Furrh, C SW Sec. 11, Blk. 31, T. & P. Sur., T-1-S — Location.

Godley Oil Co.'s No. 1 A. J. Hooks, Sec. 140, Blk. 29 — Pay 1,836-42 ft.; shot 60 qts.; 1,800 ft. oil in hole.

Marland Oil Co. and Zoch's No. 1 Jones, Sec. 32, Blk. 27, T. & P. Sur., elev. 2,218 ft. — Shut down 500 ft.

Marland Oil Co.'s No. 1 A. M. Fisher, Sec. 1, Blk. 33, T. & P. Sur., T-2-S, elev. 2,730 ft. — Drilling 650 ft.

Marland Oil Co.'s No. 1 J. B. Harding, C SE Sec. 19, Blk. 33, T. & P. Sur. — Corrected pay 3,173-3,230 ft.; shot 200 qts. 3,158-88 ft.; swabbed 125 bbls.; testing on pump.

L. C. Harrison et al's No. 1 Dora Roberts, Sec. 156, Blk. 29 — Shut down 1,650 ft.

Marland Oil Co. and Zoch's No. 1 Guitar est., No. 1, Sec. 4, Blk. A, Bauer & Cockrell Sur., elev. 2,617 ft. — Top salt 1,155 ft.; drilling 3,334 ft.

Owens & Sloan's No. 1 John Roberts, Sec. 136, Blk. 29, W. & N. W. Sur. — Drilling 1,537 ft.

HUDSPETH COUNTY

Lockhart Brothers' No. 1 Gardner & Moseley, C SE Sec. 5, School Blk. 21 — Drilling 235 ft.

IRION COUNTY

Cash Dollar et al's No. 1 G. J. Bird, NE Sec. 16, Blk. 10, S. P. R. R. Sur. — Shut down 2,500 ft.

JEFF DAVIS COUNTY

Humble O. & R. Co.'s No. 1 Crecencio Flores, Sec. 34, Blk. 58, T. & P. Sur. T-8 — Spudded new 24-in. hole.

J. K. Hughes Dev. Co.'s No. 1 J. Z. Means, 600 ft. from N line and 2,000 ft. from W line of M. Robinson Sur. No. 1 — Hole full fresh water 3,075 ft.; rainbow show at 3,180 ft.; drilling 3,350 ft.

JONES COUNTY

Atlantic O. P. Co. and Landreth's No. 2 Howell — Missed regular pay; shut down 2,700 ft.

Bateman & Campbell's No. 1 Southard, C NW NW Sec. 43, Deaf & Dumb Asylum Lands — Drilling 2,415 ft.

E. R. Brann's No. 1 E. M. Hawk, Sec. 71, Blk. 14, T. & P. Sur. — Moving in material.

Midwest Exploration Co.'s (was Campbell et al's) No. 1 L. H. Herndon, Sec. 6, M. E. P. & P. Sur., elev. 1,832 ft. — Oil sand 2,485-89 ft.; 1,800 ft. oil in hole; cleaning out.

Garland & Diamond's No. 1 E. D. Glynn, SE cor. Sec. 18, Deaf & Dumb Asylum Lands — Rig.

Gibson & Johnson's No. 1 Largent, C SE Sec. 50, Blk. 149, Dewitt Co. School Land — Drilling 2,980 ft.

Gillette & Hickey's No. 1 M. E. Young, Tevanio Sur. No. 190 — Total depth 1,450 ft.; running 8-in.

Grisham & Hunter & Wildman's No. 1 Williams, Harrison Co. School Land, elev. 1,732 ft. — Brown sand 2,620-40 ft.; tested 4 bbls. oil and 3 bbls. water; hole full salt water 2,860-72 ft.; reamed 6-in. to 2,877 ft.; hole full water 2,994-3,011 ft.; shut down.

Hutson & Weaver's No. 1 Smith, Sec. 51, Blk. 18, T. & P. Sur. — Shut down for fuel 700 ft.

Kirk & Brewer's No. 1 J. H. Milsap, Justo Rodriguez Sur., League 357 — Hole full salt water 2,403-10 ft.; shut down 2,540 ft.

Manhattan O'l Co.'s No. 1 S. W. King, Sec. 198, James Bartlett Sur. — Shut down for repairs 1,550 ft.

Marston Oil Co.'s No. 1 E. Howell, NW cor. SE W ½ of N 400 acres, Sec. 20, Blk. 19, T. & P. Sur. — Small show oil 2,496 ft.; shut down 2,545 ft.

Marston Oil Co.'s No. 1 J. S. Swan, Robert Spears Sur. No. 280 — Hole full salt water 2,390-2,400 ft. and 2,435 ft.; drilling 2,710 ft.

Mid-Continent Petroleum Corp.'s No. 1 H. Evans, NE cor. SE SE Sec. 44, S. P. R. R. Sur. — Small show oil 2,831-32 ft.; hole full water 3,020-40 ft.; drilling.

Phillips Petroleum Co.'s No. 1 Thornton — Six bbls. water 1,930-45 ft.; hole full water 3,055-58 ft.; shut down 3,088 ft.

Shaw & Rathke and others' No. 1 Bristow, SE SE Sec. 1, J. H. Gibson Sur. — Shut down 500 ft.

W. G. Stough and others' No. 1 J. P. Willis, J. C. Patterson Sur. No. 2 — Total depth 1,275 ft.; underreaming 8-in.

Swensondale Oil Co.'s No. 1 Caton, SW NW Sec. 9, Deaf & Dumb Asylum Lands — Shut down 1,655 ft.; run 10-in.

Tomberlin et al's No. 1 Oscar Clapp, CSL SW Sec. 37, Blk. 16, T. & P. Sur. — Repairs 1,555 ft.

World Oil Co.'s No. 1 Boyd (was W. H. Lee), 12,700 ft. N and 2,130 ft. E of SW. cor., Samuel Jones Sur. No. 266, elev. 1,729 ft. — Total depth 2,785 ft.; underreaming 6-in.

Kingston et al's (was Zeigler) No. 1 Reeves, C SE SE Sec. 164, B. B. B. & C. Sur. — Shut down 1,925 ft.

KENT COUNTY

Douglas Oil Co.'s No. 1 Scoggins, Sec. 57, Blk. 7, H. & T. C. Sur. — Total depth 2,620 ft.; underreaming 8-in.

Marland Oil Co. and Texon O. & L. Co.'s No. 1 Bilby, Sec. 41, Blk. K, Thompson Sur. — Location.

KINNEY COUNTY

Haveline Oil Co.'s No. 1 Weatherbee, S-c. 21, Blk. 5 — Shut down 4,330 ft.

W. A. Stevens' No. 1 Clamp, Sec. 356, Winters Sur. — Shut down 805 ft.

KNOX COUNTY

Deep Rock Oil Co.'s No. 1 Jones, CSL Sec. 111, Blk. C, H. & T. C. Sur. — Hole full water 2,850-62 ft.; repairing engine 2,867 ft.

Deep Rock Oil Co.'s No. 1 Beavers, CSL Sec. 224, Blk. 44, elev. 1,441 ft. — Total depth 2,860 ft.; fishing.

Deep Rock Oil Co.'s No. 1 Big Four, 1,270 ft. S and 2,580 ft. W of NE cor. Sec. 31, Blk. 4 — Shut down for 10-in. 1,150 ft.

Humble O. & R. Co.'s No. 1 Goode, 1,940 ft. S and 200 ft. W of NE cor. Sec. 7, H. T. & B. Sur. — Hole full water 1,710-15 ft.; drilling 1,850 ft.

The Texas Company's No. 1 J. O. Bowden, Sec. 115, Blk. 45, H. & T. C. Sur. — Standard rig.

The Texas Company's No. 1 Teague — Drilling 500 ft.

LOVING COUNTY

Kingwood Oil Co.'s No. 1 T. O. Moore, C NE Sec. 2,

Blk. G-25, Public School Land, elev. 3,120 ft. ... Top salt 1,210 ft.; show gas 1,600-15 ft.; total depth 2,725 ft.; pulling 12-in. to straightream.

Owens & Sloan's No. 1 W. D. Johnson, C SE Sec. 20, Blk. 53, T-2, T. & P. Sur. ... Shut down 1,020 ft.; in litigation.

LUBBOCK COUNTY

Sam Arnett et al's No. 1 Bowles ranch, Sec. 21, Blk. 5, G. C. & S. F. Sur. ... Drilling 550 ft.

LYNN COUNTY

The Hart Oil Corp.'s No. 1 C. O. Edwards, NW NW Sec. 5, Blk. 2, L. & S. V. Sur. ... Shut down 1,400 ft.

MIDLAND COUNTY

Orbit Oil Co.'s No. 1 Moreland, C SE Sec. 17, Blk. 39, T. & P. Sur. T-1-S ... Moving in material.

MITCHELL COUNTY

Robert Thraves' No. 1 C. Way, Sec. 91, Blk. 27, T. & P. Sur. T-1-N ... Shut down 125 ft.

Paul Teas' No. 1 Ed Strain, Sec. 82, Blk. 97, H. & T. C. Sur. ... Total depth 3,510 ft.; shut down.

Magnolia Petroleum Co.'s No. 1 T. L. McKenney, Sec. 20, Blk. 29, T. & P. Sur. T-1-N ... Drilling 3,225 ft.

Tex-O-Kan Oil Co. and Robert Thraves' No. 1 W. F. Sanders ... Drilling 320 ft.

B. E. Walter et al's No. 1 J. E. Dollen, NW cor. SW Sec. 11, Blk. 27, T. & P. Sur. ... Shut down 3,955 ft.; hole full sulphur water.

J. C. Yancey's No. 1 Saunders, 400 ft. N and 1,700 ft. E of SW cor. Sec. 25, Blk. 25, T. & ... Sur. ... Spudded and shut down.

NOLAN COUNTY

A. G. Malone et al's No. 1 J. B. Carlyle, Sec. 35, Blk. 23, T. & P. Sur. ... Material on ground.

A. G. Malone et al's No. 1 M. C. McElmurry, Sec. 36, Blk. 20, T. & P. Sur. ... Spudded and shut down; rig blew down.

J. H. Winemiller Corp.'s (was Peters et al's) No. 1 Booth, Sec. 90, Blk. 21, T. & P. Sur. ... Shut down 960 ft. for water.

Herbert Oil Co.'s (was McClesky and others') No. 1 Pepper, SE cor. SW Sec. 29, Blk. 22, T. & P. Sur. ... Rigged up and shut down.

Phillips Petroleum Co.'s No. 1 Scott, Sec. 58, Blk. 21, T. & P. Sur. ... Total depth 3,115 ft.; underreaming 8-in.

Zweifel and others' No. 1 Longbotham, C SE Sec. 130, Blk. 1, H. & G. N. Sur. ... Shut down 1,560 ft.; repairing rig.

PECOS COUNTY

George Anderson's No. 1 Sherbino Brothers, CWL NW, Sec. 43, Blk. C-4, G. C. & S. F. Sur. ... Location.

Allsman & Bell's No. 1 Pecos River Bed, 178 ft. E and 117 ft. S of NE cor. Sec. 60, Blk. 1 ... Top salt 450 ft.; total depth 860 ft.; small show oil and gas; shut down.

Benedum & Trees' No. 1 J. C. Trees, C NW SE SE Sec. 30, Blk. 7, H. & G. Sur., elev. 2,536 ... Total depth 3,115 ft.; flowing sulphur water; fishing for 36 joints 6-in.

Buell et al's No. 1 Batcheler, C N ½ NE Sec. 89, Blk. OW, G. C. & S. F. Sur., elev. 3,188 ft. ... Show oil 1,700 ft.; flowed sulphur water 1,775 ft.; fishing 2,740 ft.

Buell & Hagan's No. 1 Jasper, 1 mi. S and W NE cor. Jasper Co. School Land No. 104 ... Location.

California Co.'s No. 1 Union Land Co., Sec. 10, Blk. 141, T. & St. L. Sur. ... Drilling 1,990 ft.

Cromwell & Kimberlin's No. 1 Blackman, C NW Sec. 24, Blk. 3, H. & T. C. Sur., elev. 2,393 ft. ... Top salt 890 ft.; small show oil 1,930 ft.; half baller oil 1,948 ft.; total depth 2,126 ft.; flowing sulphur water; plugging back to shoot.

M. C. Dibble & Hale's No. 1 Bonebrake, Sec. 115, Blk. 8, I. & G. N. Sur. ... Drilling 120 ft.

Diamond Petroleum Co.'s No. 1 Blackstone & Slaughter, Sec. 27, Blk. 2-A ... Location.

Bob Elmore's No. 1 M. Holmes, Sec. 542, Blk. 1, I. & G. N. Sur. ... Shut down 100 ft.

Garland & Mott's No. 1 El Paso Cattle Loan Co., C NE Sec. 26, Blk. 126, T. & S. L. Sur. ... Rigging up.

Geo. A. Henshaw, Jr., No. 1 Snyder, Sec. 29, Blk. 144, T. & St. L. Sur. ... Location.

Kershaw & Livingston's No. 1 Cannon, SW cor. NE Sec. 54, Blk. A-2, T. C. R. R. Sur. ... Location.

Mazda Oil Co.'s No. 1 M. A. Smith ... New location.

Mid-Kansas and Transcontinental's No. 2 Yates-B, 1,320 ft. N and E of SW cor. Sec. 61 ... Drilling 665 ft.

Moutray Oil Co.'s (was Pecos Big 3 Oil Co.'s) No. 1 Robertson, Sec. 28, Blk. 10, H. & G. N. Sur. ... Drilling 160 ft.

Olean Petroleum Co.'s No. 1 Arthur Harral, C SE Sec. 98, Blk. A-2, T. C. R. R. Sur. ... Location.

Olean Petroleum Co.'s No. 1 G. A. Harral, C SW Sec. 82, Blk. B-3, G. C. & S. F. Sur. ... Moving in material.

Olean Petroleum Co.'s No. 1 Sherbino Brothers, C NW Sec. 31, Blk. C-4, G. C. & S. F. Sur. ... Moving in material.

Quinby Oil Co.'s No. 1 Townsite, Sec. 1, Blk. 267, Client Addition Sur, Fort Stockton ... Shut down 3,440 ft.

Quinby Oil Co.'s No. 2 Bennett, C NW 592, Blk. 105, G. C. & S. F. Sur., elev. 2,560 ft. ... 200 ft. oil in hole from 1,216 ft.; shot 20 qts. 1,208-20 ft.; hole full sulphur water 1,452 ft.; total depth 1,457 ft.; shot 130 qts. 1,353-60 ft.; no results; fishing.

Quinby Oil Co.'s No. 1 A. A. Gray, 660 ft. N and 1,320 ft. E SW cor. Sec. 593, Abst. 3,009 ... Shut down 680 ft.

Red Bank Oil Co.'s No. 1 Arthur Harral, C SE Sec. 35, Blk. C-4, G. C. & S. F. Sur. ... Location.

Red Bank Oil Co.'s No. 1 McKenzie, C N ½ Sec. 21, Blk. 126, T. & St. L. Sur. ... Rigging up.

Seventy-Five Oil Co.'s No. 1 F. A. Perry, C SE NW Sec. 19, Blk. 178, T. E. R. R. Sur. ... Drilling 1,770 ft.

W. R. Shankel et al's No. 1 I. G. Yates, CSL SW SE SE, Sec. 58, Blk. 1, I. & G. N. Sur. ... Top salt 425 ft.; shut down 930 ft.

Simms Oil Co.'s No. 1 A. J. Dowlin, C NE Sec. 12, Blk. 105, G. C. & S. F. Sur. ... Location.

Texon O. & L. Co.'s No. 2 I. G. Yates ... Rainbow show 1,075 ft.; show oil 1,243 ft.; shut down 1,740 ft.

Texon O. & L. Co.'s No. 3 I. G. Yates ... Location.

Texon O. & L. Co. and Marland Oil Co.'s No. 1 Blakesley, SW cor. Sec. 90, Blk. 11, H. & G. N. Sur. ... Top salt 840 ft.; flowing sulphur water 2,095 ft.; shut down 2,245 ft.

John Droppiemann's No. 1 Mrs. L. Hershenson, Sec. 7, Blk. 51, T. & P. Sur. T-10 ... Top salt 2,640 ft.; drilling 3,000 ft.

World Oil Co.'s No. 1 Serf, SW cor. NE Sec. 10, Blk. 130, T. & St. L., elev. 3,425 ft. ... Location.

PRESIDIO COUNTY

Headlock & Miller's No. 1 Tootle est., Sec. 123, Blk. 3, D. & P. Sur. ... Drilling 2,550 ft.; carrying 6-in.

REAGAN COUNTY

Henshaw & Camp's No. 1 University, Sec. 14, Blk. 48, University Land ... Rig.

Marland Oil Co.'s No. 1 University-Anderson, Sec. 19, Blk. 58, University Land ... Location.

Tidal Oil Co.'s No. 1 University, NW cor. NE Sec. 20, Blk. 3 ... Top salt 1,302 ft.; total depth 2,775 ft.; underreaming 8-in.

REEVES COUNTY

Deep Rock Oil Co.'s No. 1 Caldwell, C SW Sec. 22, Blk. 58, T. & P. Sur., Twp. 8 ... Drilling 3,775 ft.; hole full sulphur water 3,590 ft.

Exploration Co.'s No. 1 A. A. Kinney, 1,500 ft. W of NE cor. Sec. 26, Blk. C-18, Public School Land ... Spudded 20 ft. and shut down.

Humble O. & R. Co.'s No. 1-B Kloh, C NE Sec. 47, Blk. 56, T. & P. Sur. T-2-S, elev. 2,781 ft. ... 900 ft. sulphur water 1,760-1,800 ft.; shut down 2,380 ft.

David R. Thompson's No. 1 A. A. Eddins ... New location.

World Oil Co.'s No. 1 Biggs, C SE Sec. 65, Blk. 112, Public School Land Sur., elev. 3,068 ft. ... Shut down 1,610 ft.; tools moved to No. 1 Duff.

World Oil Co.'s No. 1 Duff ... Total depth old hole 1,400 ft.; drilling 1,460 ft.

RUNNELS COUNTY

Associated Petroleum Co.'s (was Bell & Moore's No. 1 W. W. King), 1,200 ft. W of NE cor. Lge. 14, J. V. Cobrera Sur. ... Spudded and shut down.

Moore & Bell's No. 1 Ferguson, 2,640 ft. S and 1,320 ft. E of NW cor. F. J. Ford Sur. No. 152 ... Spudded and shut down.

Noble Oil Co.'s No. 1 Simms, Sec. 12, J. J. McHenry Sur. ... Drilling 1,240 ft.; 15 bbls. salt water per hour; running 10-in.

Lou Ladd et al's (was Frank Yates') No. 1 R. M. McMillan ... Small show oil and gas 545-62 ft. and 590 ft.; drilling 2,215 ft.

Rhome et als No. 1 R. M. McMillan, Sec. 532, Domingo Diaz Sur. ... Hole full water 2,017 feet; total depth 2,023 ft.; to set 6-in. casing.

SCHLEICHER COUNTY

Beavers & Leath et al's No. 1 J. A. and W. T. Whitten, C NW Sec. 35, Blk. 11, T. O. Sur. ... Spudded and shut down.

Thomas Grey et al's No. 1 Bal Robinson, C NW Sec. 25, Blk. M, G. H. & S. A. Sur. ... Drilling 1,090 ft.

SCURRY COUNTY

Northwest Co.'s No. 1 T. C. Stinson, NE NW SW, Sec. 101, Blk. 97, H. & T. C. Sur. ... Tested 8 bbls. 1,745 ft.; another pay at 3,402-07 ft.; bailed 76 bbls. oil in 4 hours and bailed dry; drilling 4,465 ft.

STERLING COUNTY

Inland Oil Co.'s No. 1 Durham, Sec. 12, Blk. T, T. & P. Sur. ... Location.

J. P. Williams' No. 1 Clark, NE NE SW Sec. 7, Blk. 8, G. C. & S. F. Sur. ... Shut down 1,089 ft.; making 2 bbls. oil; top pay 1,079 ft.

L. Little's No. 1 Fisher Bros., Sec. 1, Blk. T, T. & P. Sur. ... Drilling 980 ft.

Orr et al's No. 1 Neal Reed, CNL Sec. 15, Blk. 30, W. & N. W. Sur. ... Moving in tools.

STONEWALL COUNTY

J. P. Johnson's No. 1 R. P. Morrow ... New location.

R. F. Garland & Co.'s (was McCamey & Zoch's) No. 1 J. Ward, C SW Sec. 153, Mrs. Ward Dob s Sur., 3 mi. NW of Aspermont ... Drilling 1,800 ft.

TAYLOR COUNTY

A. J. Brown et al's No. 1 Henslee, NE cor. Sec. 5, Blk. 4, S. P. R. R. Sur. ... Drilling 780 ft.

Dorning & Perrine's No. 1 J. A. Hammer, C N 100 acres, Sec. 23, Blk. 19, T. & P. Sur., elev. 1,904 ft. ... Shut down 455 ft.

Gilbert Johnson's No. 1 C. M. Brown, Sec. 1, Blk. 6, T. & P. Sur. ... Location.

W. E. Halbert et al's No. 1 Hunt, C SE Sec. 124, Blk. 64, H. & T. C. Sur. ... Shut down 1,940 ft.

Humble O. & R. Co.'s No. 1 Mattie Jacoba, Sec. 1, Nabors Sur. ... Swedging 2,520 ft.

Midwest Explin. Co.'s No. 1 Dora Smith, Jose Gabo. Sur. ... Hole full salt water 3,275-80 ft.; shut down for orders 3,280 ft.; enough gas to burn.

Morrison & Thompson's No. 1 Mrs. Alice Rose, SW cor. NE Sec. 29, Blk. 19, T. & P. Sur., elev. 1,925 ft. ... Fishing casing 2,540 ft.

Owen & Sloan's No. 1 Lattimer, Sec. 14, Blk. 9, T. & P. Sur. ... Drilling 1,840 ft.

Roeser & Pendleton's No. 1 Sam Hutman, C W ½ NW Sec. 64, Blk. 5, T. & P. Sur. ... Total depth 710 ft.; running 12-in.

Sanger O. & R. Co.'s No. 1 Ike Brown, NE cor. Sec. 54, Blind Asylum Land ... Shut down 1,900 ft.; tools in hole.

Sanger O. & R. Co.'s No. 1 Stem ... Location.

World Oil Co.'s No. 1 J. R. Griffith, SW cor. NE Sec. 32, Blind Asylum Land, elev. 1,747 ft. ... Total depth 2,120 ft.; underreaming.

TERRY COUNTY

Kingsland Oil & Potash Co.'s No. 1 Brownsfield, C NW SW SW Sec. 7, Blk. 1-A, E. L. R. R. Sur. ... Shut down 1,309 ft.

TOM GREEN COUNTY

Camp's No. 1 H. D. Wilkey, Sec. 4, B. A. L. Sur. ... Fishing baller 447 ft.

Fitzgerald et al's No. 1 Bennett ... Drilling 120 ft.; caving.

Marland Oil Co.'s No. 1 Llano, 3,500 ft. S and 13,000 ft. W of NE cor. Llano Co. School Land No. 964 ... Six-in. landed at 2,990 ft., steel line measurement.

UPTON COUNTY

Beaty et al's No. 1 J. F. Lane ... Top salt 880 ft.; sulphur water 2,370 ft.; show oil 2,250-65 ft.; drilling lime 3,550 ft.

W. W. Donnelly et al's No. 1 University, C SW Sec. 21, Blk. 4, University ... Top salt 1,560 ft.; drilling 3,750 ft.

Hults et al's No. 1 Giddings, C Sub. Sec. 12, Throckmorton Co. School Land ... Top salt 1,515 ft.; shut down 3,615 ft. for pipe.

Levi Smith and Marland's No. 1 University, C E ½ Sec. 17, Blk. 5, University Land ... Spudding.

Marland Oil Co.'s No. 3 Burleson, T. C. Jones Sur. No. 100 ... First pay 2,205 ft.; second pay 2,295 ft.; 2,000 ft. sulphur water 3,390-95 ft.; 1,000 ft. su phur water 4,135 ft.; drilling 4,517 ft.

Marland Oil Co.'s No. 34 Burleson, Sec. 100, T. C. Jones Sur. ... Shut down 3,255 ft.

Simms Oil Co.'s No. 1 B. C. Clark, NE cor. SW, Sec. 5, G. C. & S. F. Sur., elev. 2,473 ft. ... Top salt 470 ft.; top lime 1,718 ft.; sulphur water 1,834-50 ft.; total depth 1,915 ft.; underreaming 6-in.

VAL VERDE COUNTY

A. Blume et al's No. 1 Moore est., Sec. 183, J. Mitchell Sur. ... Shut down 3,000 ft.

Curso Williams' No. 1 Holman, NE NE Sec. 5, Blk. N, G. H. & S. A. Sur. ... Fishing 2,920 ft.

Douglas Oil Co.'s No. 1 Sellars, C SE Sec. 82, Blk. A, I. & G. N. Sur. ... Rig burned 2,940 ft.

East Del Rio Oil Co.'s No. 1 Russell, SE cor. Sec. 183, Del Rio Town Sur. ... Shut down 3,142 ft.; cleaning out.

Hiawatha Oil Co.'s No. 1 Sellars, C Sec. 1,031, Blk. A, I. & G. N. Sur. ... Hole full salt water 2,455 ft.; drilling 2,640 ft.

Magnolia Petroleum Co.'s No. 1 Whitehead, Sec. 81, Blk. D, G. C. & S. F. Sur. ... Shut down for fishing tools 190 ft.

Independent Operators' No. 1 Whitehead, SE SE Sec. 20, Blk. 4, I. & G. N. Sur. ... Shut down 3,900 ft.

O. O. Owens' No. 1 Mills, Sec. 128, Blk. 1, I. & G. N. Sur. ... Flowing sulphur water 2,300-25 ft.; fishing casing 2,440 ft.

WARD COUNTY

Marland Oil Co.'s No. 1 J. Sealey, C SE Sec. 78, Blk. A, G. M. M. & A. Sur., elev. 2,820 ft. ... Hole full fresh water 970-80 ft.; top salt 1,100 ft.; hole full sulphur water 3,245-48 ft.; run 6-in. 3,294 ft.; repairing motor 3,405 ft.

WINKLER COUNTY

Atlantic O. P. Co.'s No. 1 Hendricks, Sec. 34, Blk. B-5 ... Drilling 530 ft.

Champlin Drilling Co.'s No. 1 C. W. Cowden, C SW Sec. 21, Blk. C-23, Public School Land, elev. 2,889 ft. ... Hole full water 2,385 ft.; shut down 2,425 ft.; 6-in. frozen.

Group 1 Humble O. & R. Co.'s No. 1 T. G. Hendricks, C SE Sec. 36, Blk. 27 ... Shut down 820 ft.

Humble O. & R. Co.'s No. 1 T. G. Hendricks, S and W NE cor. W ½ NE Sec. 33, Blk. B-5, Public School Land ... Drilling 575 ft.

Independent O. & G. Co.'s No. 1 Hendricks, Sec. 42, Blk. B-5, Public School Land ... Total production to June 8 864 bbls.; pumped 90 bbls. cut oil June 7 and 40 bbls. June 8; pay 3,049-60 ft.; total depth 3,093 ft.

Independent O. & G. Co.'s No. 1 Hendricks-A ... Drilling 1,050 ft.

Independent O. & G. Co.'s No. 2 Hendricks-A ... Rigging up.

Llano Oil Co.'s No. 1 Scarborough, C Sec. 1, Blk. C-22, Public School Land, elev. 2,921 ft. ... Top salt 1,115 ft.; hole full water 1,321 ft.; 10-in. set 1,570 ft.; set 8-in. 2,680 ft.; top pay 2,990 ft.; total depth 3,094 ft. in sand and shale; rerunning 8-in. to bottom.

McCullough Oil Co.'s No. 1 Tobe Morton, CEL Sec. 20, Blk. B-12, Public School Land — Hole full salt water 1,940 ft.; fishing 1,980 ft.

L. D. Ladd, Hill et al's No. 1 Amburgey, C NW Sec. 24, Blk. B-7, Public School Land Sur., elev. 3,033 ft. — Top salt 1,220 ft.; top lime 3,365 ft.; total depth 3,447 ft.; rig burned; tools moved away.

R. S. Matthews et al's No. 1 State, C Sec. 7, Blk. A-57, Public School Land Sur., elev. 3,120 ft. — Shut down 750 ft.

Pure Oil Co.'s No. 1 Hendricks, SW cor. Sec. 41, Blk. B-5, Public School Land — Total depth 1,552 ft.; fishing underreamer.

Skelly Oil Co.'s No. 1 M. M. Leeman, 1,320 ft. E of SW cor. Sec. 21, Blk. 75, elev. 2,951 ft. — Top salt 1,167 ft.; drilling 4,450 ft.

Southern Crude Oil Pur. Co.'s No. 3-C Hendricks, SE cor. NE Sec. 33, Blk. B-5 — Top salt 1,870 ft.; little gas 2,630-40 ft.; drilling 2,662 ft.

Southern Crude Oil Pur. Co.'s No. 4-C Hendricks — Drilling 2,180 ft.

Southern Crude Oil Pur. Co.'s No. 1 Hendricks-B, SE cor. NE Sec. 44, Blk. 26 — Drilling 2,420 ft.

Southern Crude Oil Pur. Co.'s No. 1-F Hendricks, Sec. 33, Blk. B-5 — Rigging up rotary.

Texon O. & L. Co.'s No. 1 Central State Bank, SW cor. W ½ SE Sec. 41, Blk. B-5 — Drilling 920 ft.

White Eagle O. & R. Co.'s (was Gibson & Johnson's) No. 1 R. A. Lock, 1,320 ft. W of NE cor. Sec. 30, Blk. 74, NW of discovery well — Shut down 1,030 ft.; 10-in. froze.

WILDCAT OPERATIONS IN PANHANDLE

(Continued from Page 48)

CHILDRESS COUNTY

Brookins et al's No. 1 Mrs. Givens, 600 ft N and W of SE cor. Sec. 676, W. & M. W. Sur. — Spudded and S.D.

Hoover & Calloway's No. 1 O. L. Tucker, Sec. 786, Haggard Sur. — Rig.

C. L. Sloane et al's No. 1 B. P. Smith, Sur. 49, F. P. Knott lands — Drlg., 2,800 ft.

COLLINGSWORTH COUNTY

Harmon & Deems' No. 1 Wilson (Scott), Sec. 44, Blk. 21 — Loc.; temporarily abd.

Wischkamper's No. 1 fee, C SE Sec. 93, Blk. 16 — S.D., 2,500 ft.

COTTLE COUNTY

Exploration Co.'s No. 1 Richards — Spudded.

Sun Oil Co.'s No. 1 Tom Burnett, C NW SE, Sec. 6, Blk. L, S. P. R. R. Sur. — Drlg., 2,590 ft.

DALLAM COUNTY

James et al's No. 1 fee, Sec. 9, 47½ — S.D., 2,870 ft.

Harry Skelly et al's No. 1 Capitol Synd., Sec. 19, Blk. 17 — Resmued operations; fish. 2,925 ft.

Marland Oil Co. et al's No. 1 Capitol Synd., Sec. 36, Blk. 18, Capitol Synd. land — S.D., 950 ft.

DEAF SMITH COUNTY

Julian & DeGrace's No. 1 Mrs. R. A. Hindley, Sec. 47, Blk. K-8 — S.D., 520 ft. for casing.

Red Hill Oil Corp.'s No. 1 Barrett, Sec. 93, Blk. K-1 — S.D., 710 ft.

DONLEY COUNTY

A. T. Drlg. Co.'s No. 1 F. E. Harington, Sec. 39, Blk. 3-C — 1,200 ft. water. 3,115-22 ft: show gas, 3,140-60 ft; dry granite wash, 3,260-93 ft; drlg., 3,495 ft.

DICKENS COUNTY

Bowser Mickels et al's No. 1 Pitchford ranch, Sec. 1, Blk. 1, Sam Lazarus Sur. — S.D., 3,400 ft.

GRAY COUNTY

Atlantic O. P. Co.'s No. 1 Combs & Worley, NW cor. NE Sec. 39, Blk. 3 — Drlg., 360 ft.

Archer, Blake et al's No. 1 Turneau, Sec. 111, Blk. 2-B — Spudded and S.D.

Amos et al's No. 1 Crews, NW cor. Sec. 9, Blk. 25 — S.D., 1,545 ft. for 8¼-in casing.

Bay Shore Oil Co.'s No. 1 C. W. Bradford, Sec. 143, Blk. 2-B — T.D., 2,666 ft; gas shut in and preparing to drill deeper.

British-Amer. O. Co.'s No. 1 J. E. Meers, Sec. 107, Blk. 3 — 58,000,000 ft. gas and slight spray oil; S.D., 3,190 ft; will possibly complete as gasser.

British American Oil Co.'s No. 1 J. M. Patton, Sec. 61, Blk. B-2 — Rigged and S.D; temp. abd.

Cole O. & G. Co.'s (was Magdalene Oil Co.'s) No. 1 J. E. Williams, Sec. 17, Blk. 1 — Drlg., 3,847 ft.

Donley Gray Oil Co.'s No. 1 J. W. Gordon — Building rig.

Jack Doyle's No. 1 D. W. Osborne, SE cor. Sec. 109, Blk. 3 — Rig.

Edwards et al's No. 1 E. J. Case, NE cor. Sec. 182, Blk. B-2, H. & G. N. Sur. — Spudded and S.D.

Empire G. & F. Co.'s No. 1 J. E. Cubine, NE cor. NW Sec. 36, Blk. 25 — 10-in. casing set, 1,801 ft.

Empire G. & F. Co.'s No. 1 J. A. Hood, SW cor. SE Sec. 33, Blk. 3 — Spudding.

Empire G. & F. Co.'s No. 1 J. M. Saunders, SW cor. SE Sec. 4, Blk. 3 — Drlg., 1,110 ft.

Empire G. & F. Co.'s No. 1 J. F. Meers, NE cor. SE Sec. 107, Blk. 3 — 2,000 ft. oil in hole from lime and granite wash, 3,116-45 ft; drlg.

Empire G. & F. Co.'s No. 1 J. J. Wall, Sec. 161, Blk. 3 — T.D., 2,930 ft.; S.D; 43,000,000 ft. gas; closed in; to drill deeper.

Empire G. & F. Co.'s No. 1 Webb, SW cor. Sec. 59, Blk. 25; elev. 2,534 ft. — Drlg. by whipstock, 3,455 ft.

Gladis Gray's No. 1 Colebank-Morse (was Foster et al's No. 1 G. Cutebank), SW cor. NE Sec. 65, Blk. 25 — 2,905 ft., T.D; plugged back to 2,803 ft; shot 160 qts., 2,430-2,510 ft; 1,200 ft. oil in hole; bailed dry.

Gulf Prod. Co.'s No. 1 Bowers, Sec. 89, Blk. B-2 — Drlg., 340 ft.

Gray County Pet. Co.'s No. 1 Herndon, Sec. 147, Blk. 3 — Drlg., 2,840 ft.

Gray County Pet. Co.'s No. 1 A. Chapman — Building rig.

John G. Lane's No. 1 A. Chapman, Sec. 19, Blk. A, C. & H. B. Sur. — T.D., 3,300 ft; 5 3/16-in. casing parted; S.D.

Nelson Holding Co.'s No. 1 W. P. Dial, C NE SW NW, Sec. 48, Blk. 25 — Abd. loc.

Neudigate et al's No. 1 A. Chapman, NE cor. E half SE Sec. 52, Blk. 25 — Drlg., 1,200 ft.

Pampa Oil Co.'s No. 1 W. R. Campbell, Sec. 90, Blk. 3 — Drlg., 910 ft.

Pampa Pet. Co.'s No. 1 Mary Leopold, Sec. 141, Blk. 3 — Water, 3,230-60 ft; slight oil show in granite wash, 3,572-75 ft.

Petroleum Explrn. Co.'s No. 1 L. C. McConnell, SE cor. NW Sec. 174, Blk. 3 — Rig.

Purple Sage Oil Co.'s No. 1 Johnson, Sec. 8, Rockwell County school land — First oil show, 2,645 ft; water, 2,660 ft; show oil in granite wash, 2,790-95 ft; 8-in. casing set, 2,803 ft; show gas, 2,814 ft.

Riley & Heck's No. 1 Mrs. Hopkins, Sec. 66, Blk. 2-B — Show oil, 3,020 ft; dropped 6-in. casing in hole; drlg. by 11 joints 6-in.

Rensoul Pet. Co.'s (was Salisbury & Reynolds') No. 1 M. Huselby, C SE NE NE Sec. 55, Blk. 25, H. & G. N. Sur. — Flow, 30 bbls. daily from granite wash topped, 2,467 ft; fish. bit.

Roxana Pet. Corp.'s No. 1 Combs & Worley, NE cor. NW, Sec. 39, Blk. 3 — Spudding.

Roxana Pet. Corp.'s No. 1 R. S. McConnell, NE cor. E half SW. Sec. 174, Blk. 3 — Spudding.

C. B. Shafer's No. 1 G. Cole, SE cor. W half SW Sec. 105, Blk. 3 — Fish. for pipe, 3,313 ft; 2,000 ft. oil in hole.

Sullivan et al's No. 1 fee, NW cor. E half SW, Sec. 1, Blk. 1, A. C. H. & B. Sur. — Location.

The Texas Company's No. 1 J. B. Barrett, NE cor. NW NW, Sec. 130, Blk. 3 — Gas, 3,100 ft; 2,000,000 ft., 3,115-20 ft.

J. Williams et al's No. 1 C. W. Bradford, Sec. 123, Blk. B-2 — Rig temporarily abd.

HALL COUNTY

Seifert et al's No. 1 Owens, C NE Sec. 179, Blk. S-5, Dennison & Pacific Sur. — Spudded and S.D.

HOCKLEY COUNTY

El Capitan Oil Co.'s No. 1 Ellwood, SW cor. Sec. 55, Blk. A, R. M. Thompson Sur., 18 mi. NW Lubbock — Drlg., 1,300 ft.

World Oil Co.'s No. 1 Ellwood, Sec. 6, Wilbarger County school land — Location.

HARTLEY COUNTY

Amerada Pet. Corp.'s No. 1 Frances Farwell, Sec. 27, Blk. 16 — Drlg., 3,729 ft.

Deep Rock Oil Co.'s No. 1 Lymann & Balfour, Sec. 9, Blk. 2 — Show gas and rainbow of oil, 2,560 ft.

Eslick et al's No. 1 J. B. Irving, Sec. 13, Blk. 13 — Drlg., 3,185 ft.

J. E. McKanna's No. 1 Frances Farwell, Sec. 30, Blk. 22 — Drlg., 2,480 ft.

J. E. McKanna's No. 1 J. M. Shelton est., Sec. 29, Blk. 202 — S.D., 3,595 ft; cas. trouble; rig blown down; rebuilding rig.

HEMPHILL COUNTY

Hoover et al's No. 1 Schaller est., Sec. 4 — Spudded and S.D.

Hoover et al's No. 1 fee, J. S. Hood Sur. — Flsh., 4,430 ft.

HUTCHINSON COUNTY

Amarillo Oil Co.'s No. 1 Ida Ingerton — Drlg., 2,027 ft.

Anderson & Pritchard's No. 2 William Yake, SW cor. NW, Sec. 1, Blk. J, H. & G. N. Sur. half mile W of No. 1 — Rigged.

Beam et al's No. 1 Cockrell, Sec. 3, Blk. 23 — Spudding.

Berryman Oil Co.'s No. 1 Sanford, Sec. 83, Blk. 46, H. & T. C. Sur. — 80,000,000 ft. gas, 2,690-2,905 ft; show oil, 2,915 ft.

Big Coach Oil Co.'s No. 1 Dunnaway, Sec. 5, Blk. Y — Drlg., 750 ft.

Conklin et al's No. 1 Johnson, Sec. 1, Blk. XO3, H. & O. B. Sur. — S.D. 600 ft. for 12-in.

Great Plains Oil Co.'s No. 1 Kingland, Sec. 4, Blk. Y Y2, T. T. R. R. Sur. — Show gas, 2,325 ft; S.D.

Great Plains Oil Co.'s No. 1 Kingsland, Sec. 4, Blk. Y — Flsh., 1,620 ft.

Golden Eagle Oil Corp.'s No. 1 J. Q. Bost, Sec. 6, Blk. Y-2 — Derrick.

McMan O. & G. Co.'s No. 1 Albert Yake — Rig.

Marland Oil Co.'s No. 1 Carver, Wm. Heath Sur. — Drlg., 3,700 ft.

Panfield Oil Co.'s No. 1 Luginbyhl Bros., Sec. 50, Blk. M-23 — S.D., 1,200 ft.

Pole Cat Oil Co.'s No. 1 W. B. Haile, Sec. 24, Blk. M-21 — Drlg., 2,200 ft.

Phillips Pet. Co.'s No. 1 Yake, Sec. 36, Blk. 46 — S.D., 2,730 ft. for cable tools.

Prairie O. & G. Co.'s No. 1 J. M. Sanford, SW cor. N half Sec. 85, Blk. 46 — Drlg., 1,890 ft.

Prairie O. & G. Co. and Vacuum Oil Co.'s No. 1 Cal Merchant — Drowning out 75,000,000 ft. gas, 2,252-2,470 ft; T.D., 2,560 ft; fishing.

Skyrocket Oil Co.'s No. 1 Mrs. R. A. Jameson — Flsh., 2,512 ft.

Sweeney et al's No. 1 Johnson, Sec. 38, Blk. Y — S.D., 1,780 ft.

U. S. Oil Corp.'s No. 1 Johnson, Sec. 35, Blk. Y — Drlg., 1,525 ft.

Vitek Oil Co.'s No. 1 W. F. Allen, Jose Rodriguez Sur. — S.D., 180 ft.

KING COUNTY

Gibson & Johnson's No. 1 Burnett est. — S.D., 2,500 ft.

Midwest's No. 1 Patton — Drlg., 2,059 ft.

J. L. Pattison's No. 1 Patton — S.D., 2,065 ft.

Phillips Petroleum's No. 1 — Drlg., 3,125 ft.

Sinclair — Drlg., 1,975 ft.

White Eagle's No. 1 — S.D., 2,530 ft.

LIPSCOMB COUNTY

Camp Creek Oil Co.'s No. 1 Mrs. H. D. May, Sec. 612, Blk. 43 — S.D., 600 ft.

McCorkle's No. 1 A. Barton, NE cor. SW SE, Sec. 104, Blk. 43, H. & T. C. Sur. — Flsh., 3,760 ft.

Smith, Kinsley & Ruby's No. 1 C. W. Jones, NE cor. SW, Sec. 100, Blk. 43 — S.D., 2,565 ft.

MOORE COUNTY

Amarillo Oil Co.'s No. 2 Terry Thompson, Sec. 19, Blk. 44 — Making 34,000,000 ft. gas; drlg. lime, 3,425 ft.

Douglas Oil Co.'s No. 1 H. M. Beauchamp, Sec. 112, Blk. 44 — Drlg., 3,425 ft; 12,000,000 ft. gas.

Marland Oil Co.'s No. 1 J. T. Sneed, Jr., Sec. 25, Blk. 1 — Half baller water per hr., 3,152-3,202 ft; S.D., 3,355 ft.

Morton & Co.'s No. 1 Reeder, Sec. 191, Blk. 3-T — U.R., 3,225 ft; 3,325 ft. show gas.

Moore County Oil Co.'s No. 1 Sneed, Sec. 30, Blk. 6-T — Drlg., 2,219 ft.

Shadler Bros.' No. 1 John Lowery, Sec. 237, Blk. 44 — Drlg., 1,465 ft.

Skelly Oil Co.'s No. 1 Armstrong & Byrd — Drlg., 1,410 ft.

Prairie and Shamrock's No. 2 Gober, Sec. 16, Blk. M-21 — Rig.

MOTLEY COUNTY

Chechaco Oil Co.'s (J. W. Pennington et al of Amarillo) No. 1 J. W. Owens, NW cor. Sec. 26, Blk. 4 (15,000-acre solid block) — Fish. bit, 2,805 ft.

Exploration Co.'s No. 1 Burleson — Spudded.

Exploration Co.'s No. 1 Tillson — Drlg., 600 ft.

Wheeler et al's No. 1 C. D. Bird, C NE Sec. 4, Blk. S, Stephens Sur. — Rig.

OCHILTREE COUNTY

W. G. Burton's No. 1 Stickler, Sec. 579, Blk. 43 — S.D., 3,910 ft.

Hamilton et al's No. 1 R. E. Wamble, Sec. 144, Blk. 43 — S.D., 250 ft.

McCorkle Pipe Line Co.'s No. 1 R. H. Moore, Sec. 471, Blk. 43 — S.D., 1,600 ft.

McCorkle's No. 1 Weinett, Sec. 674, Blk. 43 — Drlg., 525 ft.

Standard Dev. Co.'s No. 1 Bowden, Sec. 923, Blk. 43 — S.D., 900 ft.

OLDHAM COUNTY

Prairie O. & G. Co.'s No. 1 Landergin, SE cor. NE SW Sec. 46, League 310, Capital land — 8-in. set 3,351 ft; S.D., 3,560 ft.

PARMER COUNTY

Humble O. & R. Co.'s No. 1 Farwell; elev. 4,005 ft — Ordered plugged and abd. at 3,503 ft.

POTTER COUNTY

Del Rio Oil Co.'s No. 1 River Bed, Sec. 106, Blk. 46, H. & T. C. Sur. — New loc; rig.

ROBERTS COUNTY

Big Bend Oil Co.'s No. 1 Mrs. H. Ledrick & Sons, Sec. 7, Blk. 5-A — Show gas, 4,990 ft; show oil, 4,992 ft; S.D. for liner.

Dunbar's No. 1 H. A. Gill, Sec. 127, Blk. M-2 — Cellar; temporarily abd.

Gibson Oil Corp.'s No. 1 T. S. Jones — Salt water, 4,143-60 ft; T.D., 4,220 ft; pulling pipe to plug.

Murphy et al's No. 1 Gill, Sec. 31, Blk. M-2 — S.D., 650 ft.

Charles Page et al's No. 1 Hamilton, Tract 2, Clay County school land — S.D., 440 ft.

C. C. Wilson, No. 1 A. H. Tandy, NE cor. Sec. 182, Blk. 42, H. & T. C. Sur. — Rigged up.

SHERMAN COUNTY

Gibson Oil Co.'s No. 1 Bivins, Sec. 35, Blk. 3-B — Flsh., 1,385 ft.

Hagy & Harrington's No. 1 S. F. Flores, C SW Sec. 64, Blk. 3-T, T. & N. O. Sur. — S.D., 300 ft.

Phillips Pet. Co.'s No. 1 Price & Fuqua, C NE, Sec. 33, Blk. 2-B, G. H. & H. Sur. — Rigged.

Whitehead et al's No. 1 Lee Bivins, C SW Sec. 36, Blk. 2, G. H. & H. Sur. — Location.

SWISHER COUNTY

R. H. Miller's No. 1 Todd — Loc. temporarily abd.

WHEELER COUNTY

American Ref. Co.'s No. 1 E. E. Carlton, Sec. 29, Blk. 13 — 8,000,000 ft. gas; show oil, 2,027 ft; T.D., 2,255 ft; plugging back to shoot.

Angus et al's No. 1 G. A. Morgan, SW cor. SW NE Sec. 93, Blk. 17 — Making 24,000,000 ft. gas, 1,800-95 ft; S.D., 1,895 ft.

Angus et al's No. 1 Vermillion, SW cor. NW SW, Sec. 80, Blk. 17, H. & G. N. Sur. — Rigged.

Boyles & Johnson's No. 1 S. L. Lewis, Sec. 40, Blk. 24 — Fish. for bit, 2,400 ft.

Foster et al's No. 1 S. H. McDonald, SE cor. NW SW, J. N. Lindsay Sur. — Spudded and S.D.

Marland Oil Co.'s No. 2 W. E. Bentley — Show gas, 2,205 ft; S.D. by agreement.

J. J. Rook's No. 1 M. Mertel, SE NE Sec. 4, Blk. 24, H. & G. N. Sur. — S.D., 1,885 ft; making 3,000,000 ft. gas, 1,880-85 ft.

J. J. Rook Co.'s No. 1 T. C. Jones, Sec. 1, Blk. 34 — Flsh. casing, 1,300 ft.

J. J. Rook's No. 1 C. W. Porter, SW cor. NW Sec. 41, Blk. 24 — S.D., 2,300 ft. by agreement

Wheeler O. & G. Co.'s No. 1 P. J. Sorenson, Sec. 53, Blk. A-4 — Spudded and S.D.

Smith Brady et al's No. 1 P. J. Sorenson, Sec. 53, Blk. A-A — S.D., 2,112 ft. for orders.

E. L. Woodley, Jr.'s No. 1 Woodley, Sr., Sec. 13, Blk. 5-A — Show oil, 2,227 ft; S.D. 2,349 ft.

Watchorn O. & G. Co.'s No. 1 F. E. Shelton, C NE NE Sec. 22, Blk. 24 — 200,000,000 ft. gas killed; drlg., 2,007 ft.

The Texas Company's No. 1 B. P. Sewell — Drlg., 1,435 ft.

Tidal Oil Co.'s No. 1 W. E. Bentley — Preparing to run 8¼-in pipe at 1,608 ft.

Technical Questions Answered

BY CHARLES K. FRANCIS, PH.D., TECHNICAL EDITOR

The Question and Answer Department of The Oil and Gas Journal is devoted to the manufacturing branches of the oil industry. Those connected with the refining of crude petroleum, the manufacture of natural gasoline and closely allied industries are invited to submit their problems to Dr. C. K. Francis, technical editor. The department was created for the purpose of aiding managers, superintendents, engineers, chemists and all those engaged in the various phases of plant operation; also those connected with the marketing and utilization of petroleum products.

Questions should be submitted in as much detail as possible so as to assure a satisfactory answer.

All inquiries should be signed and if other than the given initials are to be used please indicate the desired letters.

Questions involving patented processes, intricate formulas and calculations and estimates of costs, for obvious reasons, cannot be answered. The replies will appear on this page within a reasonable time.

KINDS OF CYLINDER STOCKS AND THEIR MANUFACTURE

How many kinds of cylinder stocks are there and how are they made?—B. R. S.

The raw material for cylinder stocks is the residue remaining in the still after the removal of the lighter fractions, when the distillation is not carried far enough for the formation of coke. The control over the extent to which the reduction may be carried is the flash point and cylinder stocks are usually made to flash not below 500 degrees Fahrenheit. Many oils crack to a considerable degree when heated above 500 and then begin to deposit coke or carbon in addition to the formation of tar. Bottom steam is used in the still to prevent this, through the agitation, which prevents burning of the oil, and the reduction of the vapor pressure, which permits removal of the products at lowered temperatures. The final residue is called steam reduced or steam refined cylinder oil.

If it is necessary to filter the oil through fuller's earth, the product after the filtering operation is called filtered cylinder stock. Very frequently the raw material is treated with acid before filtering. The extent to which color enters into the classification of cylinder stocks is indicated by means of the letters D and E. The D stock is steam refined cylinder stock which has been filtered to a D color, and the E stock is one which has been filtered to an E color. Some crude oils yield a stock having a good color upon direct reduction and are marketing without further treatment.

All of the above may contain considerable wax, the quantity depending upon the character of the crude, and consequently have a high pour point. The original method used in Pennsylvania to improve this property of the cylinder stocks was to put the crude in storage before winter. As the atmosphere became colder there was a gradual lowering of the temperature in the tank which caused a separation of the wax. The wax slowly settled to the lower part of the tank. This process was uncertain because extremes in temperature, especially when they came toward the end of the season, so altered the conditions that the desired separation was not obtained. Natural cold settled crude oil had a pour point in the upper part of the tank between 55 and 65 degrees Fahrenheit, while the oil in the lower part of the tank would have a pour point around 100 degrees. The cold settling process was improved by finishing the oil with the wax in it, diluting this with naphtha and then chilling the mixture by artificial means. A more recent advancement has been made through the introduction of the centrifugal process. The operation is the same up to wax removal stage, including naphtha dilution and artificial refrigeration. The wax is extracted by means of large centrifuge operating at a speed close to 17,000 revolutions per minute. The cooled solution is introduced into the machine and the wax particles, being heavier than the solution, are thrown to the outer edge by centrifugal force. There are outlets which provide for the proper separation of the wax (petrolatum) and the oil. The oil made by this process is known as bright stock and has a lower pour test than that made by the cold settling process.

SUN TEST FOR COLOR STABILITY

What is the method which is used for determining how a gasoline will stand up as to color when exposed in the bowls of visible pumps? Does the darkening of gasoline by light change its action in the automobile?—A. C. T.

None of the national societies has formulated a test for determining the influence of light upon petroleum products and the fact that gasoline may darken in color when exposed to the rays of the sun, has not been recognized in any specification. There is no evidence that the darkening of gasoline causes any deterioration in motor fuel value.

The color stability test, or sun test, may be made by exposing four ounce samples in ordinary oil sample bottles to the direct rays of the sun. The exact color in terms of Saybolt numbers should be determined before exposing the samples—and then hourly observations may be taken. Definite changes may occur within four to six hours. A slight darkening will require measurement by means of the color instrument to determine the change. Sometimes there may be a milky cloud produced or a yellowish brown color developed. Some refiners test products for light action by means of exposure to the ultra violet rays obtained by artificial means.

Just what happens to the composition of a petroleum product through the action of light is not known. It appears that in many cases at least, a short exposure often causes a bleaching action, but prolonged exposure causes darkening. There is some evidence that the refining process, especially the sweetening operation, introduces changes in the composition of gasoline through the formation of bodies which are very sensitive to the action of light. These may be compounds of sulphur or complex salts containing sodium and lead. Excess sulphur causes loss of color stability against light.

The color of gasoline, either before the sun's rays have acted or after, can have nothing to do with engine performance. There is no more connection between color and power, than there is between odor and heat units.

DISTILLATION SPECIFICATIONS FOR GASOLINES

Will you please give me the specifications, distillation, etc., of an ideal gasoline of the following grades: 58-60 437 endpoint; 60-62 400 endpoint; 64-66 375 endpoint? Will you please give me the specifications which most of the refineries use in making these three grades of gasoline?—K. S. W.

The 437 endpoint gasoline is commonly known as Motor Gasoline, from the fact that most of the motor fuel purchased for the use of the Federal departments is obtained under the specification for United States Government Motor Gasoline, of which the following is an outline:

Gravity—None. The gravity of 58-60 is simply a marketing condition.

Color—Not darker than No. 16 Saybolt.

Distillation range—Initial boiling point—Not above 131 Fahrenheit. Recovery shall be 20 per cent at or below 221 Fahrenheit; Recovery 50 per cent at or below 284 Fahrenheit; Recovery 90 per cent at or below 392 Fahrenheit. Endpoint 437 Fahrenheit. Loss not over 5 per cent.

Sulphur—Not over 0.10 per cent. Corrosion test—Copper not stained after three hours in the gasoline at 122 Fahrenheit.

The 400 endpoint gasoline should meet the following:

Gravity—60-62.
Color—Not below 25 Saybolt.
Doctor test—Negative.
Acidity—None.
Sulphur—Below 0.10 per cent.
Corrosion test—Negative.
Distillation range—Initial below 110 Fahrenheit. Endpoint 400 Fahrenheit. Recovery 95 per cent.

The 375 endpoint gasoline is sometimes known as Export gasoline, also Domestic Aviation. The following are specified:

Color—No. 25 Saybolt.
Doctor test and Acidity—Negative.
Corrosion test—No black coloring or gum deposits over 3 mg. in a copper dish after evaporating 100 c.c.
Distillation range—Recovery shall be 5 per cent between 122 and 167 Fahrenheit. Recovery 50 per cent at or below 221 Fahrenheit; Recovery 90 per cent at or below 311 Fahrenheit; Recovery 96 per cent at or below 347 Fahrenheit. Endpoint, not above 374 Fahrenheit. Total recovery 98 per cent.

The refiner is guided by these specifications; of course, making his product so that it will, when tested, come well within the limits set.

UNSATURATED HYDROCARBONS IN GASOLINE SPECIFICATIONS

Should the percentage of unsaturated hydrocarbons or percentage soluble in sulphuric acid be included in specifications for gasoline?—C. C. C.

A very large number of many different kinds of substances may be included in the term unsaturated hydrocarbons. The unsaturated hydrocarbons are compounds which contain in their structure one or more double or triple bonds. This classification includes the olefines, acetylenes, and all the cyclic hydrocarbons.

The very elementary meaning of the term unsaturated may in a general way indicate the most prominent characteristic of these bodies—that is—(they are not saturated, some other substances may be added to them. The degree of saturation is frequently measured in terms of the addition of some element such as bromine or iodine.

The cyclic hydrocarbons and the compounds of the benzol group, or aromatics exhibit their unsaturated character when subjected to the action of various chemicals. The heavier petroleum substances are more liable to contain unsaturated bodies than the lighter or lower ones. The production of synthetic gasoline from the heavier fractions of the crude oil through rearrangement of molecular structure, also favors the formation of cyclic bodies and especially certain members of the aromatic group. Many of these unsaturated hydrocarbons have been recognized as having a tendency to diminish knocking and thus have what has been commonly termed antiknock value. The ordinary processes used by refiners for the purification of gasoline involve treatment with chemicals and these frequently reduce saturation—in other words the product is less saturated after the refining operation than before.

Petroleum as formed in different parts of the world varies in composition and this is especially marked in some oil with respect to the quantity of unsaturated hydrocarbons found in them. The quantity of unsaturated bodies being so definitely fixed in some oils as to constitute a means of identification.

Additional data might be given concerning unsaturated bodies in gasoline but the above information is probably suggestive enough to indicate that it is unnecessary to include in gasoline specifications the percentage of unsaturated hydrocarbons. The quantity soluble in sulphuric acid is simply one method and certainly a method which could not receive extensive approval by petroleum chemists. It may be said in conclusion that the acid soluble number aside from indicating the source of the crude and the character of the bodies present can have but little influence in determining the value of the motor fuel.

A BOAT LOAD OF GASOLINE OR OIL

What is the quantity of gasoline or crude oil which is carried in the tank steamers when these products are exported?—D. R. M.

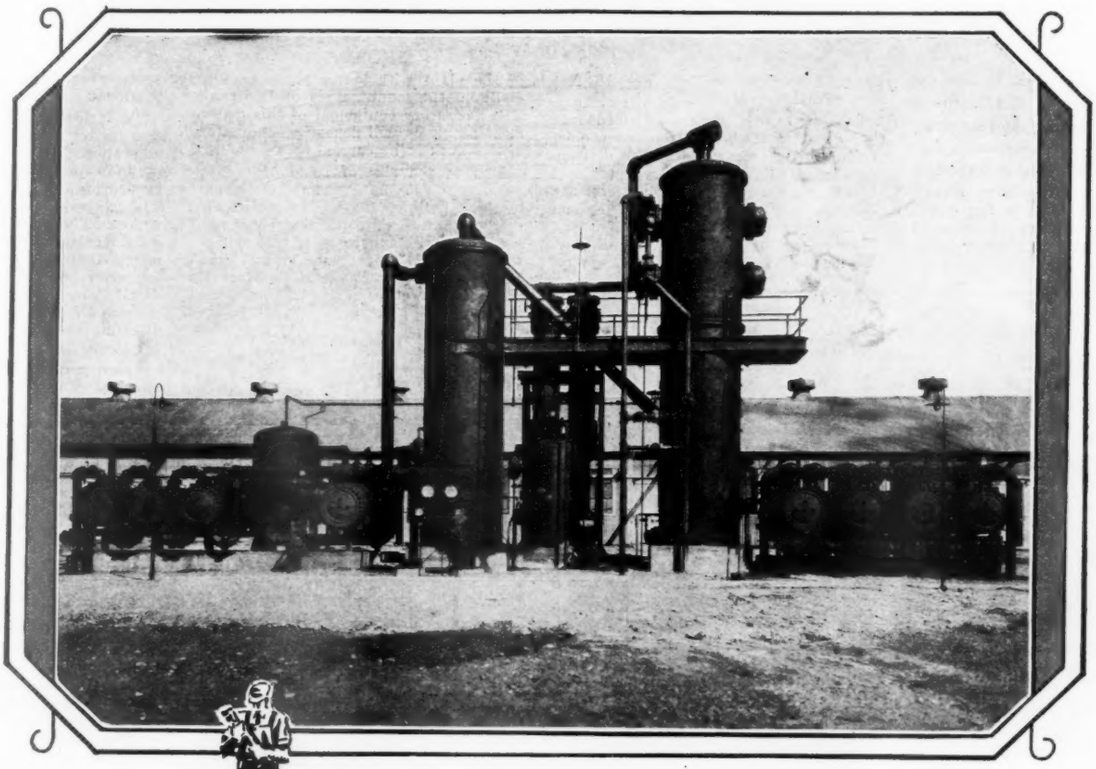
The tankers used in the export service range in size from about 10,000 to 15,000 tons. The larger boats transport crude oil, chiefly from Mexico at this time, in quantities around 125,000 bbls. The quantity of gasoline or kerosene handled is somewhat less. The usual cargo of these products is between 1,000,000 and 2,000,000 gallons. There are a few ships which load about 3,000,000 gallons, or approximately 70,000 bbls. of gasoline.

IODINE AND BROMINE IN WATER FROM OIL WELLS

What are the quantities of bromine and iodine present in the salt water found in oil wells?—S. W. H.

There is some evidence that the water which is encountered when drilling for oil is very similar in composition to that of sea water. F. W. Clarke, Data of Geochemistry—quotes several authorities who have determined the quantity of iodine in sea water. It is reported to be in the form of calcium iodate. The quantity estimated was one part of calcium iodate to 250,000 parts of water, equivalent to about 2 parts per million of iodine. Smaller quantities are reported by others. Bromine appears in very much larger quantities and figures by the United States Geological Survey show sea water to contain 22.4 parts per million of iodine and 1,800 parts per million of bromine. The water from the wells in the Sunset Field in California contains according to Watts, approximately 20 parts per million of iodine.

An interesting application of iodine and bromine content is suggested by Mrazec, as noted by C. E. Ristle, Jr. Identification of Oil Field Waters,—Technical Paper 404 United States Bureau of Mines. Mrazec states that the water of the Rumanian oil fields contains iodine when the water is found associated with oil—and the same water contains little or no bromine. However when water is not associated with oil the reverse is true. In other words waters rich in bromine are found away from oil deposits, and oily waters contain iodine.



Portable, Mobile, and Fabricated plants with a range of gasoline capacities up to 40,000 gal./24 hr. *Lower cost per gallon* of gasoline produced ★

BRAUN

Absorption Plants

C·F·BRAUN & CO

Manufacturing Mechanical Engineers

·ALHAMBRA·CALIF·

TULSA · NEW YORK · DALLAS

Laboratory in Refinery Operations

Marland Plant Has Separate Building With Complete Equipment for All Types of Testing and Experimental Work

By C. O. Willson

PONCA CITY, Okla., June 11.—One of the noticeable changes in Mid-Continent refinery operations during the past three years has been the improvement in laboratory facilities. From the makeshift arrangements which formerly characterized practically all plants a few years ago have come the modern laboratories as an essential phase of refinery operation.

Laboratory building of the Marland Refining Co. at Ponca City, Okla.

The rapid progress in laboratory organizations and equipment is explained as due to the fact that more and more refineries have come to realize that efficiency centers around laboratory control of plant operations. This situation has become particularly important with the advent of cracking and other refinery processing which is constantly becoming more complicated. Managers and superintendents have found that it is impossible to keep a constant check on their operations, including the assurance that the company's customers will be satisfied with their products, unless they have the necessary laboratory equipment operated under the direction of capable chemists. In addition to the more or less routine testing, several companies have found it expedient to maintain research organizations which are leading rather than following in the adoption of new manufacturing methods.

At its local refinery, the Marland Refining Co. gradually has enlarged its laboratory facilities and personnel until now they compare favorably with the largest of the refining industry, regardless of location. This expansion has been necessary to keep pace with the growth of the refinery, where the investment has practically been doubled during the past two years. The laboratory now serves a complete refinery with a rated capacity of 30,000 bbls. daily.

Laboratory Building

The first important change at the Marland looking to greater laboratory facilities was the construction of a laboratory building, which was completed about two years ago. The building which is shown in the accompanying photograph is located near the main entrance at a point where it is readily accessible to all departments connected with plant operations.

The building is of reinforced concrete with outside walls of red brick trimmed with Carthage stone. The building is 114 feet long and 60 feet wide with two stories, and is of fireproof construction throughout.

The building is heated by steam from the refinery boiler house, with power and light supplied by the refinery's power plant. Inside the ceilings are 18 feet high with floors of vitrified tile.

The laboratory work is divided into four departments by A. Henriksen, chief chemist of the company, and this division is reflected in the laboratory equipment of each department. The divisions are research, analytical chemical, physical testing and experimental.

Before passing to a description of these four departments, a word is necessary regarding the equipment found throughout the laboratory. All work tables have service lines supplying hot and cold water, gas, compressed air, vacuum, steam and both alternating and direct current electricity. These lines run the entire length of the tables, with outlets wherever needed.

The tables, which are made of hardwood, have drawers and cupboard space with drains and sinks. Wherever needed, provision is made for chemical hoods to carry off fumes which are either poisonous or obnoxious to those working in the laboratory. The hoods are connected to an exhaust air system which can change the air in each room every five minutes. The system consists of two motor-driven, 4-foot, slow-speed exhaust fans. These fans are located on the roof of the building with conduits leading to each room.

The research department, as the name indicates, has to do with the original investigations being made at the refinery. This department at the Marland organization, through its investigations, has been able to suggest changes in operations which have added to the efficiency of the plant with better products, especially in the manufacture of lubricants. The laboratory equipment of this department naturally will depend on the nature of the work being carried on.

Due to the size of some of the apparatus and the nature of the work, part of the experimental laboratory is located in the plant. This equipment consists of small distilling apparatus of atmospheric, vacuum and high-pressure types. Small experimental clay roasters, agitators for chemically treating oils, wax presses and ovens also are included.

Analytical Department

In the analytical chemical department chemical analyses of all kinds of materials such as oils, waxes, asphalts, greases and water are made. This department also often analyzes materials used in plant construction and operation. Part of the equipment used in one of the rooms of the analytical laboratory is shown in one of the accompanying photographs.

Physical Testing

The physical testing department is concerned with routine testing, which, nevertheless, is more important than the work of any other department, in that it makes possible a day to day check on all phases of plant operation and assures that the products manufactured are meeting the specifications requested by the sales department.

To facilitate the large amount of routine testing at the Marland refinery, the laboratory has all the equipment necessary for speed and accuracy. A dark room is provided for flash and fire testing, with a hood connection to remove all vapors. The pour test bath is cooled by a refrigerator system. A small dark room houses the color machines, thus enabling the colors to be taken with uniformity at all times. Where a warm atmosphere is needed for drying and filtering, a large warming oven has been provided.

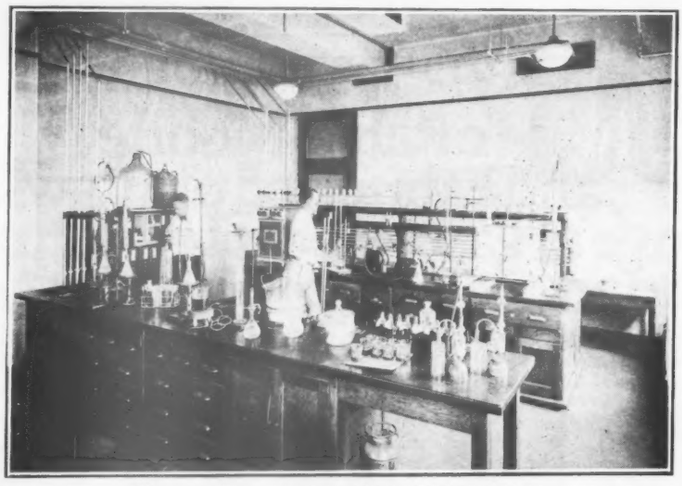
One of the accompanying photographs shows a part of the light oil testing laboratory. Tests made here include Engler distillation, gravity corrosion, doctor and steam reductions for gasoline, kerosene, light distillates, gas oils and crude oil. For cooling the Engler distillation condensers, cold brine is circulated from the refrigerating system. As every chemist knows, this not only reduces labor but also assures more accurate testing due to the fact that a uniform temperature is maintained. The ammonia refrigerating system which furnishes the cold brine is located in the basement of the building.

Additional Features

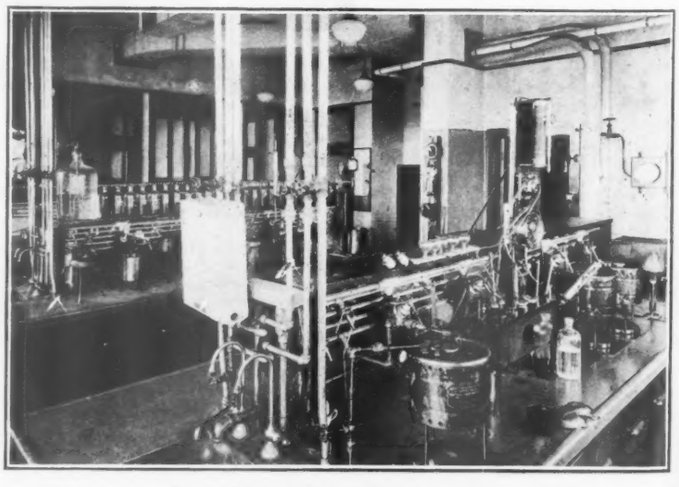
The offices of the chief chemist and his assistants are located in the laboratory. At the Marland refinery part of the operating offices for the entire refinery also are located in the building, including the plant superintendent. A library and reading room is now being equipped. This will include technical books and all journals and periodicals of interest to the refining industry. This library will supplement that located at the general offices of the Marland companies, which probably is as complete as will be found in the oil industry. The general office building adjoins the refinery site.

Centrally located so that it is accessible to the research and analytical departments is a well lighted analytical balance room, so constructed as to reduce vibrations which are detrimental to the delicate mechanism of the analytical balances. Storerooms are provided for apparatus and chemicals. In the sample room are several hundred samples of products which have been shipped from the plant and which are held for further testing if necessary.

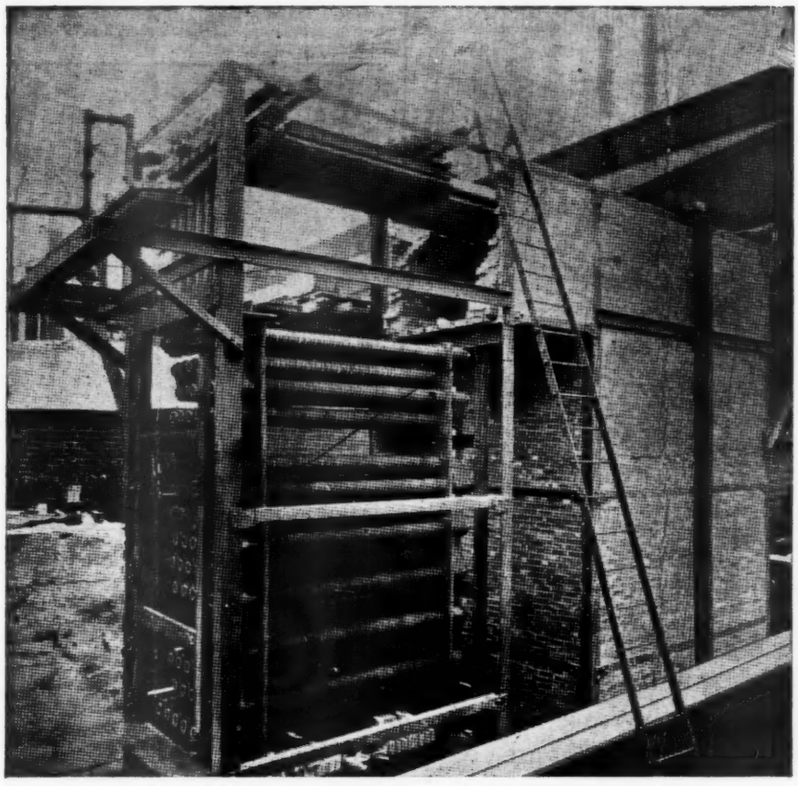
The basement houses the auxiliary apparatus of the laboratory. This includes the ammonia refrigerating units pre-



Corner of one of the analytical laboratories.



Part of lubricating oil testing room.



High temperatures without overheating

Foster Tube Stills are successfully heating oil to final temperatures as high as 1100 deg. Fahr. without cracking the oil or overheating the heater, and are successfully taking an overhead of 90 per cent of the throughput without cracking.

Performances such as these form one reason for the rapidly increasing number of Foster Tube Still installations—now in excess of 500.

POWER SPECIALTY COMPANY

111 Broadway, New York

Branch Offices in All Oil Centers

FOSTER

The TUBE STILLS

with the protected surface

Take the drudgery out of cleaning

YOU know how toilsome they are—those cleaning tasks that require hours of tedious hand scrubbing to remove encrusted oil and muck. You know how costly they are. And the risk when gasoline is used.

But you may *not* know that many of these jobs can be done without any hand labor whatever—that they can be disposed of easily, quickly and cheaply by cleaning the Oakite way. And SAFELY!

Take salvage parts. With a tank of Oakite you can clean valves, pipe fittings and similar equipment, *in bulk!* Merely soaking them in an Oakite solution removes every particle of dirt, oil and muck. Larger units like steam pumps and drilling engines can be cleaned just as thoroughly and with time and labor savings comparatively as large.

Improved economical methods for *all* your cleaning problems are explained in our booklet "Oakite in the Oil Industry." Sent free on request.

OAKITE IS MANUFACTURED ONLY BY

OAKITE PRODUCTS, INC., 44C Thames St., NEW YORK
(formerly OAKLEY CHEMICAL CO.)

Oakite Service Men, cleaning specialists, are located at

Albany, Allentown, Pa., Altoona, Pa., *Atlanta, Ga., Baltimore, *Birmingham, Ala., *Boston, Bridgeport, *Brooklyn, Buffalo, *Camden, Charlotte, N. C., Chattanooga, Tenn., *Chicago, *Cincinnati, *Cleveland, *Columbus, O., *Dallas, *Davenport, *Dayton, Decatur, Ill., *Denver, *Des Moines, *Detroit, Erie, Flint, Mich., Fresno, Cal., *Grand Rapids, Harrisburg, Hartford, *Indianapolis, *Jacksonville, Fla., *Kansas City, *Los Angeles, Louisville, Ky., Memphis, Tenn., *Milwaukee, *Minneapolis, *Montreal, Newark, Newburgh, N. Y., New Haven, *New York, *Oakland, Cal., *Omaha, Neb., *Philadelphia, *Pittsburgh, Portland, Me., *Portland, Ore., Providence, Reading, *Rochester, Rockford, Rock Island, *San Francisco, *Seattle, *St. Louis, South Bend, Ind., Syracuse, *Toledo, *Toronto, Trenton, N. J., *Tulsa, Okla., Utica, *Vancouver, B. C., Williamsport, Pa., Worcester.

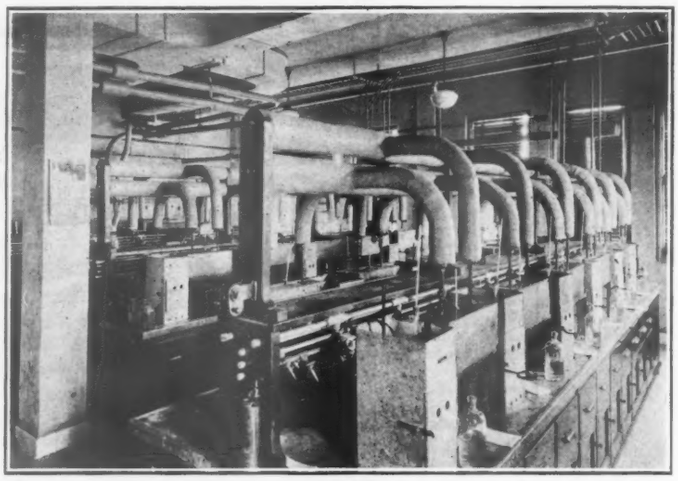
*Stocks of Oakite Materials are carried in these cities.

OAKITE

TRADE MARK REG U.S. PAT. OFF.

Industrial Cleaning Materials and Methods

viously mentioned, automatic air compressors, vacuum pump, direct current electric generator and hot water heater. The changing rooms, including baths and lockers for all plant employes, also are located in the basement of the building.



Light oil testing laboratory showing equipment for circulation of brine in making distillation tests.

July 23 Is Set Aside To Honor Discovery Of Oil in America

WELLSVILLE, N. Y., June 11.—With some of the most influential eastern oil men actively at work and other notable oil men in different parts of the United States giving the project their hearty support, the plans for the celebration of the three hundredth anniversary of the discovery of oil in America are being rapidly forwarded.

The New York State Oil Men's Association has charge of the program of exercises which will be held on the Seneca Indian reservation at Cuba, N. Y., on July 23. A monument marking the spot where petroleum was first seen by a white man on the western continent will be dedicated with elaborate ceremonies in which the New York State Historical Society, American Petroleum Institute, representatives of the state government and of the Seneca tribe of Indians, Franciscan fathers from the near-by St. Bonaventure's College and seminary, and prominent oil men will take part.

The discovery of oil by a white man is attributed to a Franciscan missionary in 1627 on land of the Seneca Indians. Father D'Aillon, the discoverer, named the oil spring the "Fontaine de Bitume." Only recently it was discovered by geologists that the oil is a seepage from the Chipmonk sand which outcrops near Cuba, and which produces in commercial quantities east and south of Olean.

Robert H. Bartlett of Tulsa, Okla., is chairman of the tercentenary organization; Harry E. Keller, Cuba, N. Y., vice chairman; Herbert J. Demcey of Cuba, secretary, and Col. N. V. V. Franchot, Olean, N. Y., treasurer.

PLANS CANCELLATION OF DRILLING PERMITS

WASHINGTON, June 11.—Commissioner William Spry of the General Land Office in the Interior Department has inaugurated steps that may result in cancellation of a large number of the permits heretofore issued under the Leasing Act of 1920 to drill for oil on the public lands.

Twenty thousand permittees either have received notice, or soon will, to show cause in 15 days from date of notification why they should not give up their permits. The Land Office began mailing these notices some weeks ago, its action being one of two moves recently initiated by the commissioner to keep the oil in the ground and to clear up his records. The other step was to charge a non-returnable service fee of $10 on all future applications for permit to drill.

Commissioner Spry said he would not be surprised if one effect of the cancellation notices would be that more than one-half of the permittees would find themselves unable to show cause why they should have an extension under the leasing law, in which event cancellation would be made effective. The number seeking permits already has been reduced by the service fee.

Wide attention in and out of the field has been attracted to the cancellation notices. Several complaints have been made, but none to the effect that greater oil production would result. Mr. Spry expressed surprise at reports in New York that "feverish drilling" was being caused, defeating the purpose of those who want to conserve the oil because of a glutted market.

The Commissioner said the cancellation notices did not mark the inauguration of "any unusual policy," but were simply in obedience to the provisions of the leasing law, which limited the life of permits to seven years unless renewed. He added it was his desire to "clean decks" as well as to "keep the oil in the ground."

OIL WELL MACHINERY EXPORTS ARE DOUBLED

Exports of industrial machinery from the United States in April were the largest for any month during the past five years. Exports amounted to $17,339,000 and represented a gain of $1,461,000 over the shipments of April, 1926, the previous high point. Exports during March, 1927, amounted to $13,949,000.

Shipments of oil-well machinery during April totaled $2,861,219, or considerably more than double those for the corresponding month of 1926. A comparison of the four-month period ending in April of each year shows a gain of more than $2,200,000.

UGLY BRITISH PETROL PUMPS

The political correspondent of the London Daily Mail writes: "I learn that Colonel Wilfrid Ashley, the Minister of Transport, has set on foot negotiations with the object of limiting the size and form of petrol filling stations, which, in his view, are tending to become needlessly large and, in many cases, spoiling the beauty of the countryside. If this move meets with success, which seems likely, the number of pumps erected at each roadside station will be limited to meet only the real requirements of the station, and it may also be possible to arrive by agreement at an approved design for the stations themselves which would free them from the garishness of many recently erected stations."

The Holmes-Manley *Cracking* Process

Flexibility of Operation.

High Yield of Quality Gasoline direct from the Unit.

Fractionation and Condensation under Full Operating Pressure.

High Yield of Liquid Products with a minimum yield of fixed gas and carbon.

Low yield of Residue Fuel Oil of good Quality.

Relatively low Operating Temperatures.

Ease of Control.

Long Runs and High percentage of Operating Time.

Low Labor and Fuel Costs.

Address Inquiries to

THE TEXAS COMPANY

W. S. S. RODGERS

17 Battery Place, New York, N. Y.

Branch Office

816 Palace Building, Tulsa, Okla.

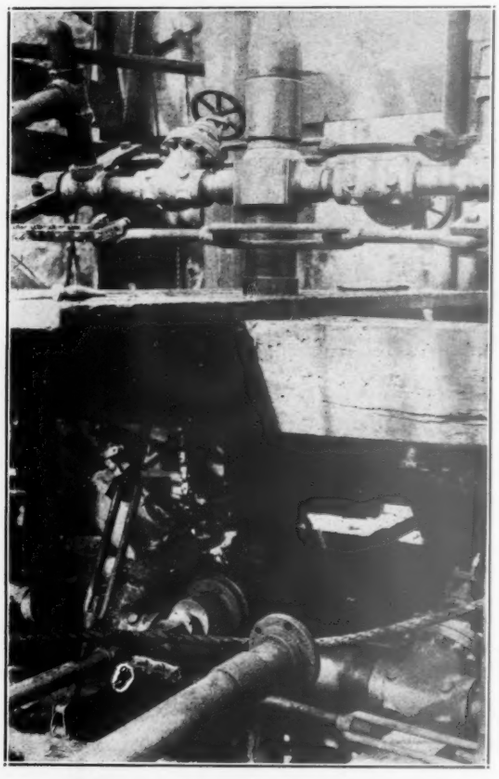
Strong *Enough!*

—to Carry the Weight of

4800 ft. of Drill Pipe

Plus

1600 Lbs. PRESSURE



The C. I. W. Blowout Preventer

(with Exclusive Patented Packing)

—has stood that test without leaking a drop—in the Bordages No. 4 well of the Vacuum Oil Co., photographed above.

This well came in with 1600 lbs. pressure BEFORE the drill stem could be removed from the hole. So the preventer rams were tightened around the stem, and the lower manifold put into operation, with the additional weight of 4800 ft. of drill pipe suspended on the rams. Later the well sanded up outside the stem, so the second manifold (covered with frost in the photo) was set up ABOVE the Preventer, and the well came back at the same high pressure—THROUGH the drill stem.

It DOES Pay to "be SAFE"!

CAMERON IRON WORKS

Manufacturers of—
Oil Well Supplies
and Fishing Tools

HOUSTON, TEXAS

PRINCIPLES OF THE AIR AND GAS LIFT

(Continued from Page 41)

than that for which the compressor is built, and in this event the air pipe would need to be raised the distance that would bring the pressure within the range of the compressor capacity. The pressure required to start the water flowing is obtained by multiplying the number of feet of submergence by 0.434 to which is to be added the pressure equivalent to the friction loss due to the air flowing through the air pipe.

The arrangement of piping shown in Figure 1, while of the usual form, is not the most efficient arrangement as will be noted in some of the following paragraphs.

Fluid Levels and Submergence in Air Lifts

The fluid level in an oil well or water well is that point to which the fluid will rise under existing conditions. If there be no discharge of the liquid from the well, the liquid will assume a static condition. If the liquid is being pumped, whether by plunger pump or air lift, the level of the liquid will be lowered, depending upon the rate at which the liquid will enter the well when the well is being pumped at any given rate.

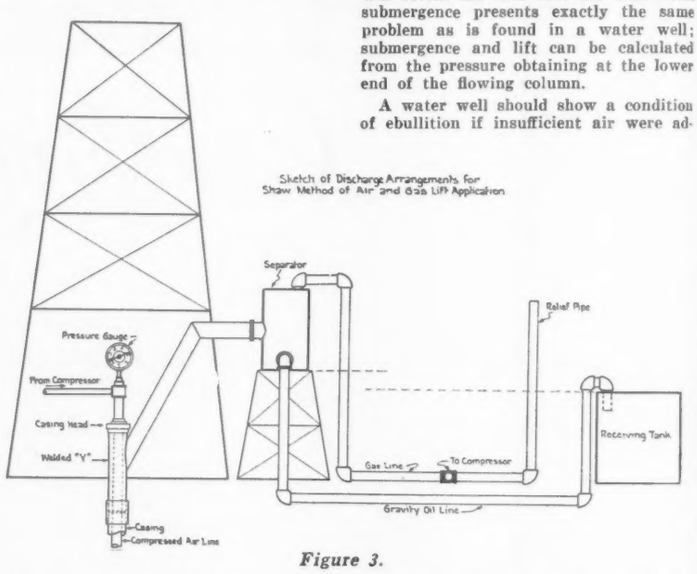


Figure 3.

The term "submergence" has been employed for many years by those versed in air lifts to denote the height of the liquid above the point at which the air is admitted at the lower end of the air tubing. When starting a well on the air lift the submergence is usually higher than when the well is being pumped; this is termed "starting submergence." When the well has reached a stationary condition it is called "working submergence." Submergence may be expressed in feet of water, feet of oil, or in pressure in pounds per square inch. Before calculations for air lifts can be made, it is necessary to determine the lift, that is, the height to which the liquid must be raised, and in order to do this it is necessary to ascertain the submergence in feet, since the total vertical length of the air pipe minus the submergence is the "lift."

There are three general types of air lift installations as follows:

1. Two pipes, side by side, connected near the lower end, the air flowing through one of the pipes to the connection, and the mixed air and liquid rising through the other pipe.

2. Two pipes, one inserted in the other and the air flowing through the inner pipe to the lower end, the mixture of air and liquid rising in the annular space between the two pipes. This is called the central air lift system.

3. Two pipes, one inserted in the other, the air passing through the annular space between the two pipes, the mixture of air and liquid rising in the inside pipe. This is called the Saunders system.

In the first type, a fluid level is maintained which can be measured. In the second and third types of fluid column is in motion in both pipes and submergence cannot be actually measured, but the level to which the fluid would rise at the instant the air is cut off from the air pipe can be determined by noting the gauge pressure at the top of the well and subtracting from this the friction loss due to the air flowing through the air pipe, thus obtaining the pressure at the bottom of the air pipe. The feet of corresponding submergence can then be determined from this figure of pressure, making allowance for the specific gravity of the particular liquid being lifted.

Oil wells which have ceased to flow, present an exact parallel to water wells as regards submergence. One may be somewhat puzzled as to the manner of handling submergence in flowing wells, but a little study in air lift practice will reveal the fact that the theoretical submergence presents exactly the same problem as is found in a water well; submergence and lift can be calculated from the pressure obtaining at the lower end of the flowing column.

A water well should show a condition of ebullition if insufficient air were admitted to cause it to flow; the level would be found higher than the level that would obtain if the column were not made lighter by the air passing through it. This does not change the considerations of submergence, however, as the water column is considered as if it had a specific gravity of 1, and not the accidental specific gravity due to variable quantities of air slipping through it. An oil well should be considered in the same manner; that is, the submergence is that which would be measured if there were no gas mixed with it and slipping through it. For a given pressure, the submergence of most oils is greater than that of water, owing to the lower specific gravity of the oil.

Owing to the comparatively great depths at which air and gas lifts are obliged to operate in oil wells, the designs of air lifts that have been employed in past years must have a great submergence; that is, where wells reach a depth of 3,000 to 5,000 feet, the submergence must range from 300 to 500 feet to secure even a low degree of efficiency. However, if the gas lift is efficiently designed, acceptable efficiencies can be obtained with submergence ranging from 100 to 300 feet, and high efficiencies are possible to reach where the submergence ranges from 300 to 1,000 feet. If the quantity of fluid to be handled is small it is not likely that a proper submergence can be obtained for the usual form of air lift and very low efficiencies would result; conditions might become such that there would be no flow whatsoever.

A range of submergence that has been employed with air lift efficiently designed is given in Table No. 6.

TRIMO

The Pipe says to TRIMO:

"Hey, Trimo, how come that your teeth are always so sharp? That bite you gave me yesterday clamped as tight as the first one you sank in my hide five years ago. That's a wicked jaw of yours. Who's your dentist?"

TRIMO replies:

"It's a gift, old top, but I'll let *you* in on the reason. That jaw of mine is renewable—see! If my molars get dull or worn, somebody just slips a new jaw in my handle and I'm as good as new. That's why you tough customers around here always get a move on when I get a strangle hold."

The Workman has his say:

"That inserted jaw business is a great thing, all right. Trimo handles last for keeps and jaws cost only a little, so I'm satisfied. You can always trust a Trimo—*but get what you ask for.* Trimo for mine!"

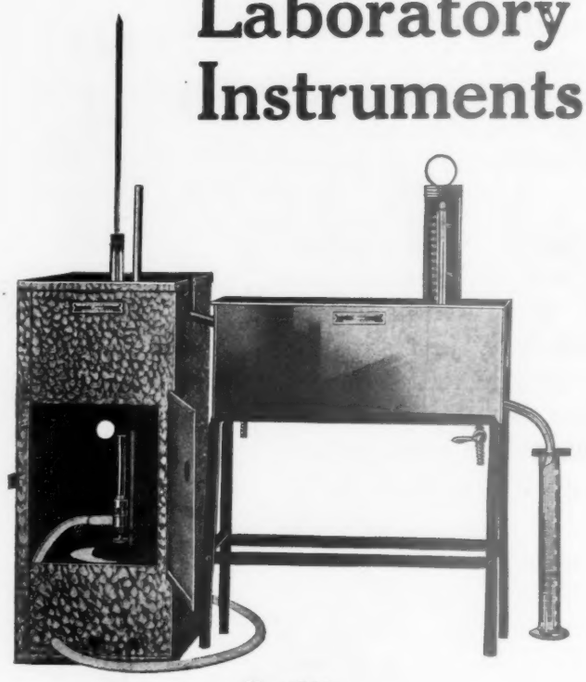
MEMO:
When a man asks for a *pipe wrench,*
he means a TRIMO

For Sale at Hardware, Plumbing and Mill Supply Stores

TRIMONT MANUFACTURING COMPANY
ROXBURY (BOSTON), MASS.

Tycos

Laboratory Instruments



No. 1753
Distillation Apparatus

The term of "*Tycos* line" includes hydrometers, thermo-hydrometers, distillation apparatus, flash and fire test cups for illuminating, lubricating and fuel oils, viscosimeters, engraved thermometers, aneroid barometers and pyrometers for laboratory testing and checking purposes.

We shall be pleased to send an oil laboratory catalog upon your request.

Taylor Instrument Companies
Rochester, N. Y., U. S. A.

Canadian Plant: Tycos Building, Toronto
Manufacturing Distributors in Great Britain:
Short & Mason, Ltd., London

Tycos
Temperature Instruments
Indicating Recording Controlling

TABLE NO. 6
Range of Air Lift Work at Charcas, San Luis Potosi, Mexico, in 1919-20

	1	2	3	4	5	6	7
Submergence, ft.	192	216	230	206	69	20	176
Lift, ft.	164	214	548	884	1,021	1,070	1,176
Gallons per min.	300	450	1,100	440	125	67	159
Bbls. per day	10,286	15,430	37,720	15,080	4,130	2,297	5,490
Cu. ft. air per gal	?	0.67	2.38	4.85	16.45	29.68	12.42
Pct. efficiency	?	67.7	44.2	38.8	22.25	30.7	20.3

Calculations Employed in Air and Gas Lift Work

An example will be given of the manner in which the efficiency of a gas lift is computed, assuming the following conditions:

Total depth of well, or length of air tubing, 4,000 feet.

Barrels produced per day, 3,000.

Gravity of the oil, 41 degrees Baume, or specific gravity of 0.82.

Total gas produced per day, 2,700,000, or 900 cubic feet per barrel.

Total gas input from compressor, 660,000 cubic feet, or 220 cubic feet per minute.

Total gas associated with the oil, 2,040,000 cubic feet, or 680 cubic feet per barrel.

Pressure at top of well, 190 pounds.

Diameter of air tubing, 2½-inch.

It is first necessary to ascertain the pressure at the lower end of the tubing, and from Tables Nos. 7 and 8, the friction loss of 220 cubic feet per minute passing through a 2½-inch pipe, 4,000 feet in length is found to be 13.8 pounds for air, and for gas at specific gravity of 0.8 would be 13.8÷1.118 or 12 pounds and the required pressure would then be 190 less 12 pounds or 178 pounds per square inch. The height of an equivalent column of water is 178×2.304 or 401 feet, and the equivalent column of oil of 0.82 specific gravity is 401÷0.82 or 490 feet which is the submergence in this case. The lift is then 4,000 feet less 490 feet or 3,150 feet. The quantity of air required to lift 1 gallon of water 3,510 feet at efficiency of 100 per cent with submergence of 178 pounds is 5.401 cubic feet (see Table No. 4) and to raise 1 gallon of oil of 0.82 specific gravity is 5.401×0.82, or 4.429 cubic feet; and per barrel of oil would be 4.429×42, or 186.6 cubic feet. The efficiency is then 186.6÷900, or 20.7 per cent. If it were required to determine the size of the compressor to compress the gas necessary to admit to the well for the above conditions, assuming the other conditions are known other than this factor, and assuming the design of the gas lift were such as to occasion, for example, the following losses:

Entrance losses at lower end of footpiece	10 %
Slippage and friction losses in eductor	50
Losses at the discharge	19.3
Total losses	79.3%

This would leave an efficiency of 20.3 per cent that would be obtained. Under the conditions of lift and submergence assumed, the quantity of gas required at 100 per cent is found as above to be 186.6 cubic feet per barrel, and at 20.3 per cent efficiency would require a total of 186.6÷20.3, or 900 cubic feet per barrel. We have previously assumed that the quantity of gas per barrel derived from the sand is 680 cubic feet therefore the quantity required from the compressor would be 900 minus 680, or 220 cubic feet per barrel and for 3,000 barrels per day the total quantity required would be 3,000 × 220 or 660,000, which is 460 cubic feet per minute. If we assume that the compressor has a volumetric efficiency of 80 per cent, the displacement capacity of the compressor must be 460÷80, or 575 cubic feet per minute. It should be remembered that this applies to sea level altitude or close to sea level. If air lift work were to be attempted at such places as Wellington, Colo., or Salt Creek, Wyo., allowance would need to be made for this difference in altitude, as noted in Table No. 5A.

Types of Gas Lift Designs

As previously noted under the caption of "Submergence" there are three general types of gas lift arrangements, as shown in Figure 2. The first type permits a higher efficiency to be obtained than any other method. In oil wells, however, the diameters of casing are usually so small that rarely can the required capacity be obtained by having separate lines side by side within the casing. It is difficult, moreover, to lower and raise in the casing two separate lines which are connected at the lower end.

The second type will cause a flow in "hands" unless the design is very close to being correct. Between heads the pressure will build up until the maximum point is reached, at which time the well will "head" and the pressure will drop to its minimum point. Between heads there is usually a continuous discharge of air or gas from the annular opening be-

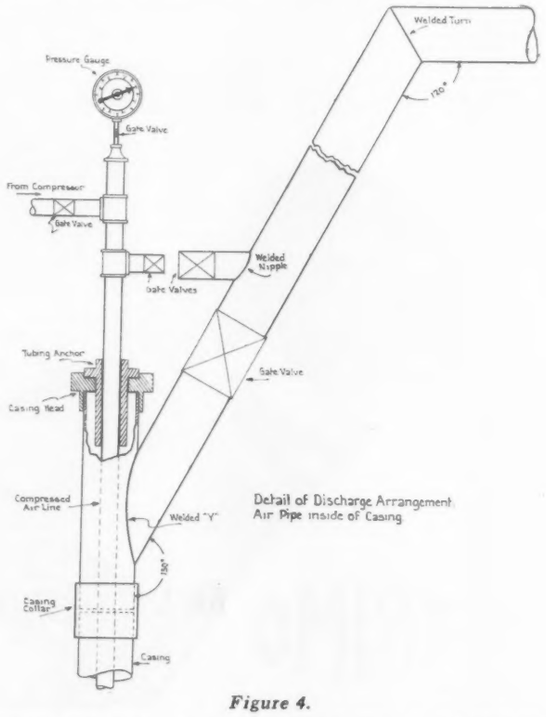


Figure 4.

Changed quickly

Bignall & Keeler pipe threading machines offer the most satisfactory method of cutting miscellaneous pipe and casing for the oil fields because they can be changed quickly from one thread or taper to another. They have ample power for the long tapered threads required. Hundreds of users the world over agree that B & K machines offer the best pipe threading equipment value. Their sturdy construction, rapid operation and freedom from complicated settings appeal to both shop owner and operator.

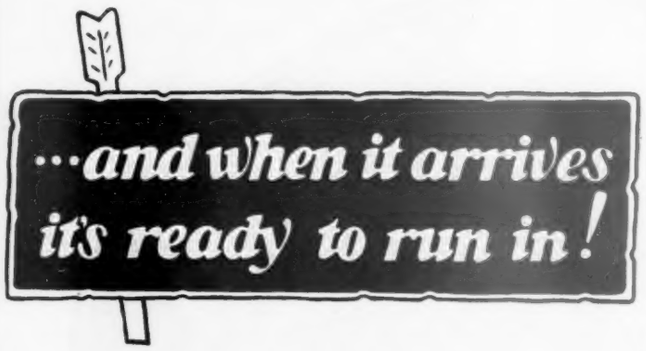
B & K machines are the product of fifty years of development and a thorough knowledge of the needs of the oil fields.

Let us send you a catalog of the complete line comprising twenty types and sizes.

BIGNALL & KEELER MACHINE WORKS
of the N. O. Nelson Mfg. Co.
Edwardsville, Ill.

PEERLESS B&K DUPLEX P.D.C.

O&GJ 6-16 Gray



When the Elliott-Alco Core Drill is delivered to your rig it is complete, in perfect working condition, ready to run in the hole. Nothing has been forgotten. No mistake has been made in sizes. You don't have to check up to see that everything is Okeh. Every extra you will need is there too.

That is the character of Service that is back of every Elliott-Alco Core Drill. It is ample but not superfluous. It has saved thousands of dollars in time and production for hundreds of operators - - - and it will for you.

ELLIOTT CORE DRILLING CO.
850 Subway Terminal Building
LOS ANGELES, CALIFORNIA

BRANCHES:

3210 Harrisburg Blvd.,
Houston, Texas

123 East 3rd Street,
Tulsa, Okla.

618 Lake Street,
Shreveport, La.

432 Park Street,
Beaumont, Texas

10 C St. Southwest,
Ardmore, Okla.

Export Office:
150 Broadway, New York City

tween the casing and tubing which represents lost energy.

In the third type as it is usually installed, the well nearly always flows in heads unless the design is nearly correct or unless an excessive quantity of gas is employed. The interval between heads is usually longer than in the second method. The range of pressure is usually greater than in the second type. At the beginning of a head there is often ejected a "plug" of liquid unmixed with gas which results from displacement of the liquid in the casing by the air. This "plug" is quickly followed by a mixture of gas and liquid, which is then followed by a longer period of almost pure gas which flows into the tubing from the space between the casing and tubing. This flow of gas continues until the pressure drops to its low point when the incoming liquid rises and closes off the escape of the gas. The waste of energy when flowing by heads in this manner is very great. Flowing in "heads" serves to build up a much higher pressure than when flowing continuously and thereby establishes temporarily a high back pressure against the sand and probably retards in some cases to a considerable extent the flow of the oil toward the well.

A continuous flow is more efficient than an intermittent flow because of requiring a smaller volume of gas to raise a barrel of oil; it operates under a lower pressure than the maximum pressure reached in intermittent, flows, being nearer the lower point than the higher point. The fluid level is lowered to a lower point than the average level when operating by "heads." It is very important to lower the fluid level to the point at which the maximum flow toward the well takes place, thereby creating a differential pressure between the sands and the well opening.

In the oil fields practically all air and gas lifts have been designed by previous experience or by guess, and take little account of efficiency. If the lift as first installed in a well produces more oil than can be pumped on the beam the designer or operator concludes that it is successful; if it fails, the lift is pronounced a failure so far as that particular well is concerned; and yet either of these instances may be far from obtaining the results that could be obtained by basing the design on a scientific knowledge of air lift principles. Nearly all oil fields differ amongst themselves in conditions, and even in wells of the same field marked differences in conditions usually exist. Unless these conditions are properly considered when making a design, there is little likelihood of obtaining efficient results. A design of air lift operating successfully in one field may easily operate unsuccessfully in another field.

The slightest change in diameter or length of pipe makes surprising changes in results. A change of one-eighth-inch in diameter, or of 50 feet in length, will make a marked change in capacity and efficiency.

The essential parts of an air lift or gas lift are as follows:

1. Footpiece, or "flow device" or pump, which is placed on the lower end of the flow tubing.

2. Flow tubing, or eductor, extending from the footpiece to the top of the well.

3. Separator, or headpiece, at the top of the well, at the upper end of the eductor.

The Footpiece

Many kinds of footpieces, or "flow devices" are found on the market, most of which are of poor design. Footpieces of standardized design can be made for various capacities for work in shafts or in large openings, but in oil wells the limitation of casing diameters are such that the writer finds it advisable to make a design to fit each set of conditions.

The Flow Tubing

To secure the best results for a given set of conditions the utmost care must be taken in designing the flow tubing. Poor designs usually result in the well flowing by "heads," and as nearly all oil wells flow by heads in which air lifts are employed, it can be taken for granted that nearly all oil well air lifts are inefficient.

Table No. 8

Quantity by which friction loss calculated for air is to be divided to obtain friction loss of a gas of given specific gravity.

Specific Gravity of Gas	Factor	Specific Gravity of Gas	Factor	Specific Gravity of Gas	Factor
0.56	1.3363	.82	1.1043	1.08	0.9623
.57	1.3245	.83	1.0976	1.09	0.9578
.58	1.3131	.84	1.0911	1.10	0.9535
.59	1.3019	.85	1.0847	1.11	0.9492
.60	1.2910	.86	1.0783	1.12	0.9449
.61	1.2804	.87	1.0721	1.13	0.9407
.62	1.2700	.88	1.0660	1.14	0.9366
.63	1.2599	.89	1.0600	1.15	0.9325
.64	1.2500	.90	1.0541	1.16	0.9285
.65	1.2403	.91	1.0483	1.17	0.9246
.66	1.2309	.92	1.0426	1.18	0.9206
.67	1.2217	.93	1.0370	1.19	0.9167
.68	1.2127	.94	1.0314	1.20	0.9129
.69	1.2039	.95	1.0260	1.21	0.9090
.70	1.1952	.96	1.0206	1.22	0.9054
.71	1.1868	.97	1.0153	1.23	0.9017
.72	1.1785	.98	1.0102	1.24	0.8980
.73	1.1704	.99	1.0050	1.25	0.8944
.74	1.1625	1.00	1.0000	1.26	0.8909
.75	1.1547	1.01	0.9950	1.27	0.8874
.76	1.1471	1.02	0.9901	1.28	0.8839
.77	1.1396	1.03	0.9853	1.29	0.8805
.78	1.1323	1.04	0.9806	1.30	0.8871
.79	1.1251	1.05	0.9759	1.31	0.8737
.80	1.1180	1.06	0.9713	1.32	0.8704
.81	1.1111	1.07	0.9667	1.33	0.8671

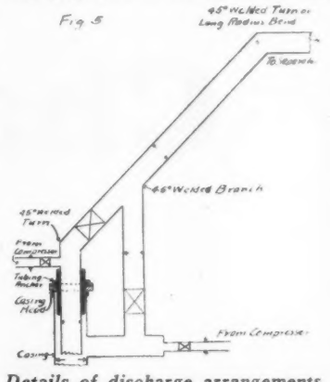
The Separator

Separators are necessary to remove the air and gas from the liquid. A simple design can be employed for air lifts where no effort need be made to conserve the gas. If it be desired to conserve the gas for fuel or to use it over again in closed circuit through a compressor it is desirable to employ a separator of substantial character.

Energy Contained in Petroleum Gas

In regard to the energy contained in petroleum gas, the United States Bureau of Mines Engineers in Bulletin No. 148, page 117 state:

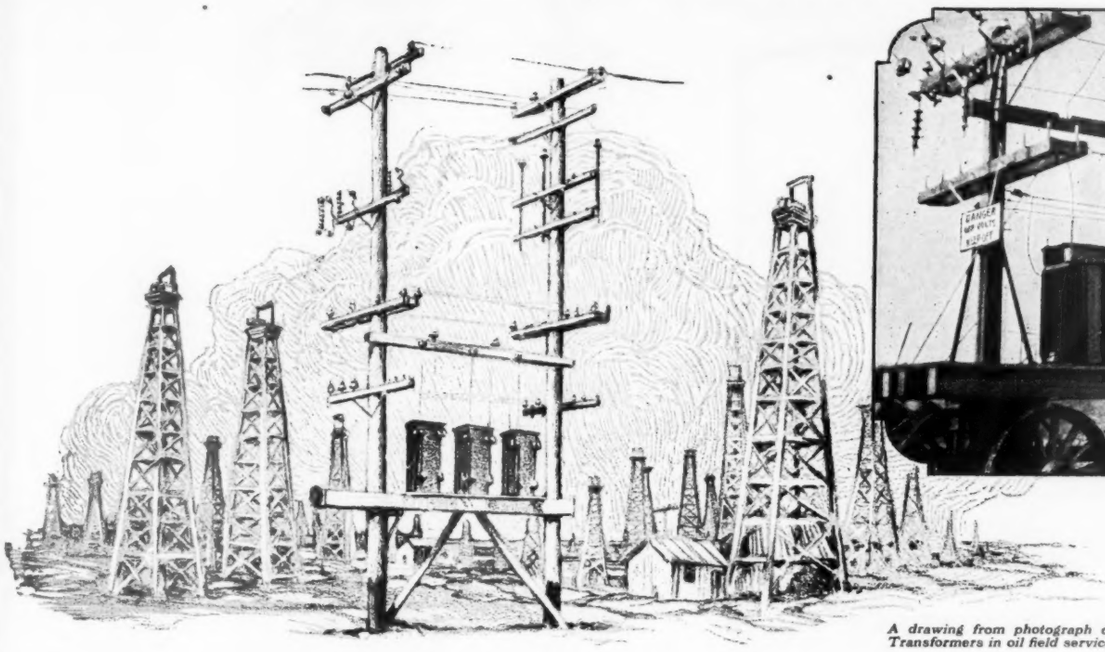
"There is a definite and limited amount of natural energy associated with the oil in each field, and largely upon how effectively that energy is utilized to expel the oil from the sand will depend on what proportion of the oil in the sand



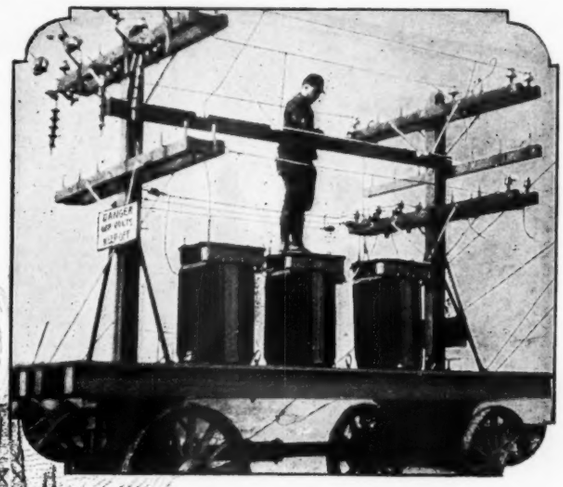
Details of discharge arrangements for Shaw method of air and gas lift with flow through inner tubing.

may be recovered, for evidently the exhaustion of a well is caused more by the exhaustion of the natural expulsive forces than by the depletion of the supply of oil. If the natural gas associated with the oil is permitted to escape unrestricted and without performing the greatest amount of work possible, the producer is lessening the quantity of oil that may be obtained by natural means. Every foot of gas produced wastefully may be considered to represent a quantity of oil that should have been brought to the surface by using the gas effectively. It appears logical to gauge the efficiency of production methods by the relative volumes of gas produced with the oil at the same well. If, for example, a change in method reduced the volume of gas produced with each barrel of oil from 2,000 to 1,000 cubic feet, much more oil could be recovered eventually, even though the actual daily production of oil were reduced a little temporarily."

The following table has been compiled from various sources to illustrate the range of gas pressures that has obtained at various oil and gas fields in the United States. This is interesting in that we can determine from the table the approximate percentage of oil that should have been recovered during flowing conditions at any field for which these figures are avail-



A drawing from photograph of bank of G-E Transformers in oil field service



This unique mounting of G-E Transformers makes a portable transformer substation for oil field use

Where Transformers Supplant Boilers

On an increasing number of leases the old steam boiler plant with its costly delays, complicated piping, and other disadvantages is giving way to more modern equipment.

Today, G-E Transformers, in compact banks, as pictured here, take electric current from incoming power lines and distribute a dependable supply to the motorized field equipment. They require no attention, suffer little depreciation, present no fire risk, and are easily installed.

General Electric's position as a builder of equipment for transmission and distribution is unique. Not only can G-E Transformer Products be supplied for every normal requirement, but a service is available to study any special problem, and, if necessary, develop the equipment required to deliver reliable power in suitable form.

General Electric supplies complete electric equipment to the oil industry. With warehouse facilities close to your operations, G-E readily furnishes motors, controllers, transformers, arresters and other protective devices, capacitors for power factor improvement, switching equipment, etc.

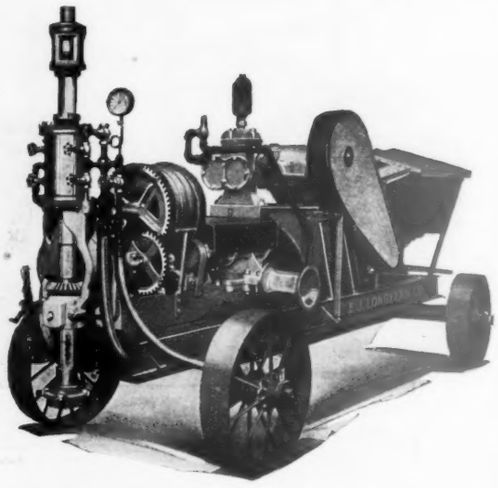
G-E oil field specialists and G-E service at: Dallas, Denver, Houston, Kansas City, Oklahoma City, Tulsa, Los Angeles, San Francisco.

Transformer Products
— the Standards of Quality

401-14

GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y., SALES OFFICES IN PRINCIPAL CITIES



Efficiency Economy Mobility

THE diamond drill for your wild-catting and structure drilling must be efficient and capable of drilling every formation you will encounter. It must be economical in its consumption of fuel and water. It should be so mounted that it can be moved from hole to hole without loss of time.

The Longyear mounted hook-up fulfills each of these requirements. It is a 2N gas operated drill with a capacity of 1,000 feet of 2-inch core or 2,000 feet of 1⅛-inch core mounted with pump and Fordson gas engine on a steel truck ready for drilling.

The drill does not have to be dismounted when in operation and the use of the gas engine does away with the necessity of setting up a boiler and making the necessary pipe connections.

The gas engine, too, is a valuable feature in regions where steam fuel is scarce and expensive or where water would otherwise have to be trucked long distances.

E. J. Longyear Company manufactures other types of drills with either gas or steam power and fitted for every drilling purpose. For any information regarding them write our Minneapolis office or our branch warehouse, Ponca City, Oklahoma.

Other Longyear activities include contract diamond drilling, shaft sinking and mine development.

E. J. Longyear Company
Minneapolis. Minnesota. U.S.A.

TABLE NO. 7

FRICTION OF AIR IN PIPES

Divide the number corresponding to the diameter and volume by the ratio of compression. The result is the loss in pounds per square inch in 1,000 feet of pipe.

Cu. Ft. Free Air per Min.	Nominal Diameter in Inches								
	½	¾	1	1¼	1½	1¾	2	2½	3
5	12.7	1.2	....	....	....	....	....	....	....
10	50.7	7.8	2.2	....	....	....	....	....	....
15	114.1	17.6	4.9	....	....	....	....	....	....
20	....	30.4	8.7	2.0	....	....	....	....	....
25	....	50.0	13.6	3.2	....	....	....	....	....
30	....	70.4	19.6	4.5	....	....	....	....	....
35	....	95.9	26.6	6.2	2.7	....	....	....	....
40	....	125.3	34.8	8.1	3.6	1.9	....	....	....
45	....	....	44.0	10.2	4.5	2.4	....	....	....
50	....	....	54.4	12.6	5.6	2.9	....	....	....
60	....	....	78.3	18.2	8.0	4.2	2.2	....	....
70	....	....	106.6	24.7	10.9	5.7	2.9	....	....
80	....	....	139.2	32.3	14.3	7.5	3.8	....	....
90	....	....	....	40.9	18.1	9.5	4.8	....	....
100	....	....	....	50.5	22.3	11.7	6.0	....	....
110	....	....	....	61.1	27.0	14.1	7.2	2.8	....
120	....	....	....	72.7	32.2	16.8	8.6	3.3	....
130	....	....	....	85.3	37.8	19.7	10.1	3.9	....
140	....	....	....	98.9	43.8	22.9	11.7	4.6	....
150	....	....	....	113.6	50.3	26.3	13.4	5.2	....
160	....	....	....	129.3	57.2	29.9	15.3	5.9	....
170	....	....	....	....	64.6	33.7	17.6	6.7	....
180	....	....	....	....	72.6	37.9	19.4	7.5	....
190	....	....	....	....	80.7	42.2	21.5	8.4	2.1
200	....	....	....	....	80.4	46.7	23.9	9.3	2.9
220	....	....	....	....	108.2	56.5	28.9	11.3	3.6
240	....	....	....	....	128.7	67.3	34.4	13.4	4.2
260	....	....	....	....	....	79.0	40.3	15.7	4.9
280	....	....	....	....	....	91.6	46.8	18.2	5.7
300	....	....	....	....	....	105.1	53.7	20.9	6.6

Cu. Ft. Free Air per Min.	Nominal Diameter in Inches								
	2	2½	3	3½	4	4½	5	6	8
320	61.1	23.8	7.5	3.5	....	....	....	....	....
340	69.0	26.8	8.4	3.9	....	....	....	....	....
360	77.3	30.1	9.5	4.4	....	....	....	....	....
380	86.1	33.5	10.5	5.9	....	....	....	....	....
400	94.7	37.1	11.7	5.4	2.7	....	....	....	....
420	105.2	40.9	12.9	6.0	3.1	....	....	....	....
440	115.5	44.9	14.1	6.6	3.4	....	....	....	....
460	125.6	48.8	15.4	7.1	3.7	....	....	....	....
480	....	53.4	16.8	7.8	4.0	....	....	....	....
500	....	58.0	18.3	8.5	4.3	....	....	....	....
525	....	64.2	20.2	9.4	4.8	2.6	....	....	....
550	....	70.2	22.1	10.2	5.2	2.9	....	....	....
575	....	76.7	24.2	11.2	5.7	3.1	....	....	....
600	....	83.5	26.3	12.2	6.2	3.4	....	....	....
625	....	92.7	28.5	13.2	6.8	3.7	....	....	....
650	....	98.0	30.9	14.3	7.3	4.0	....	....	....
675	....	105.7	33.3	15.4	7.9	4.3	....	....	....
700	....	113.7	35.8	16.6	8.5	4.6	....	....	....
750	....	130.5	41.1	19.0	9.7	5.3	2.9	....	....
800	....	....	46.7	21.7	11.1	6.1	3.3	....	....
850	....	....	52.8	24.4	12.5	6.8	3.8	....	....
900	....	....	59.1	27.4	14.0	7.7	4.2	....	....
950	....	....	65.9	30.5	15.7	8.6	4.7	....	....
1,000	....	....	73.0	33.8	17.3	9.5	5.2	....	....
1,050	....	....	80.5	37.3	19.1	10.4	5.8	....	....
1,100	....	....	88.4	40.9	21.0	11.5	6.3	2.4	....
1,150	....	....	96.6	44.7	22.9	12.5	6.9	2.6	....
1,200	....	....	105.2	48.8	25.0	13.7	7.5	2.8	....
1,300	....	....	123.4	57.2	29.3	16.0	8.8	3.3	....
1,400	....	....	....	66.3	33.9	18.6	10.2	3.8	....
1,500	....	....	....	76.1	39.0	21.3	11.8	4.4	....
1,600	....	....	....	86.6	44.3	24.2	13.4	5.1	....
1,700	....	....	....	97.8	50.1	27.4	15.1	5.7	....
1,800	....	....	....	110.0	56.1	30.7	16.9	6.4	....

Cu. Ft. Free Air per Min.	Nominal Diameter in Inches								
	4	4½	5	6	8	10	12		
1,900	62.7	34.2	18.9	7.1	....	....	....	....	....
2,000	69.3	37.9	21.3	7.8	....	....	....	....	....
2,100	76.4	40.8	23.0	8.7	2.0	....	....	....	....
2,200	83.6	45.8	25.3	9.5	2.2	....	....	....	....
2,300	91.6	50.1	27.6	10.4	2.4	....	....	....	....
2,400	99.8	54.6	30.1	11.3	2.6	....	....	....	....
2,500	108.3	59.2	32.6	12.3	2.9	....	....	....	....
2,600	117.2	64.0	35.3	13.3	3.1	....	....	....	....
2,700	....	69.1	38.1	14.3	3.3	....	....	....	....
2,800	....	74.3	41.0	15.4	3.6	....	....	....	....
2,900	....	79.8	43.9	16.5	3.9	....	....	....	....
3,000	....	85.1	47.0	17.7	4.1	....	....	....	....
3,200	....	97.1	53.5	20.1	4.7	....	....	....	....
3,400	....	109.5	22.7	22.3	5.3	....	....	....	....
3,600	....	122.8	67.7	25.4	5.6	....	....	....	....
3,800	....	....	75.5	28.4	6.6	....	....	....	....
4,000	....	....	83.6	31.4	7.3	....	....	....	....
4,200	....	....	92.1	34.6	8.1	....	....	....	....
4,400	....	....	101.2	38.1	8.9	....	....	....	....
4,600	....	....	110.5	41.5	9.7	2.9	....	....	....
4,800	....	....	120.4	54.2	10.5	3.2	....	....	....
5,000	....	....	....	59.1	11.5	3.4	....	....	....
5,250	....	....	....	54.1	12.6	3.8	....	....	....

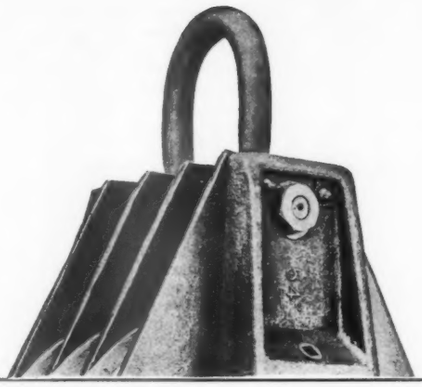
Cu. Ft. Free Air per Min.	Nominal Diameter in Inches								
	4	4½	5	6	8	10	12		
5,500	....	....	....	59.4	13.9	4.2	....	....	....
5,750	....	....	....	64.9	15.2	4.6	....	....	....
6,000	....	....	....	70.7	16.5	5.0	....	....	....
6,500	....	....	....	82.9	19.8	5.9	2.3	....	....
7,000	....	....	....	96.2	22.5	6.8	2.6	....	....
7,500	....	....	....	110.5	25.8	7.8	3.0	....	....
8,000	....	....	....	125.7	29.4	8.8	3.6	....	....
9,000	....	....	....	....	37.2	11.2	4.4	....	....
10,000	....	....	....	....	45.9	13.8	5.4	....	....
11,000	....	....	....	....	55.5	16.7	6.5	....	....
12,000	....	....	....	....	66.1	19.8	7.7	....	....
13,000	....	....	....	....	77.5	23.3	9.0	....	....
14,000	....	....	....	....	89.9	27.0	10.5	....	....
15,000	....	....	....	....	103.2	31.0	12.0	....	....
16,000	....	....	....	....	117.7	35.3	13.7	....	....
18,000	....	....	....	....	148.7	44.6	17.4	....	....
20,000	....	....	....	....	....	55.0	21.4	....	....
22,000	....	....	....	....	....	66.9	26.0	....	....
24,000	....	....	....	....	....	79.3	30.1	....	....
26,000	....	....	....	....	....	93.3	36.3	....	....
28,000	....	....	....	....	....	108.0	32.1	....	....
30,000	....	....	....	....	....	123.9	48.2	....	....

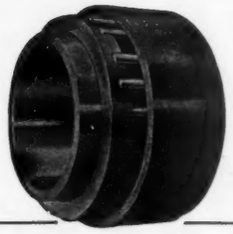
This table printed by permission of the School of Mines and Metallurgy, University of Missouri.

able if the full lifting value of the gas were utilized.

Gas Pressure at Various Fields

Place	Depth	Lbs. Pressure
Arkansas—		
Smackover	2,200	950
California—		
Dominguez	4,054	516
Dominguez	4,300	580
Dominguez	4,277	530
Dominguez	4,411	760
Dominguez	4,326	630
Rosecrans	4,707	620
Rosecrans	4,125	800
Rosecrans	4,926	510
Colorado—		
Wellington	4,285	1,400
Indiana—		
Kokomo	650	328
Kansas—		
Caney	1,500–1,700	525
Chanute	....	262
Cherryvale	....	221
Coffeyville	....	346
Fredonia	....	301
Humboldt	....	295
Independence	....	390
Iola	835–975	309
LeHunt	....	382
Vilas	....	330
Louisiana—		
Caddo	3,623	1,200
Caddo	1,650	650
Caddo	1,800	600
Montana—		
Havre	947	490
Havre	1,370	546
Ohio—		
Belmont Co.	1,310	365
Belmont Co.	1,465	440





Taking out friction—putting in smoothness with

AMERICAN HEAVY DUTY TYPE "C" ROLLER BEARINGS

Stand in any derrick while the traveling block is doing its stuff over a deep hole. You can actually *feel* the smoothness of operation if the block is equipped with Heavy Duty Type "C" American Roller Bearings. This Roller Bearing takes away much of the jerking, squeaking and vibration, characteristic of blocks using plain bearings. They introduce a smoothness in starting, stopping, pulling, etc., that makes the whole job easier on the driller, the derrick, the tools, and the pipe.

American Bearings are made to do just that: —to handle heavy strains without straining, to run without ructions, to be strong and non-sticking.

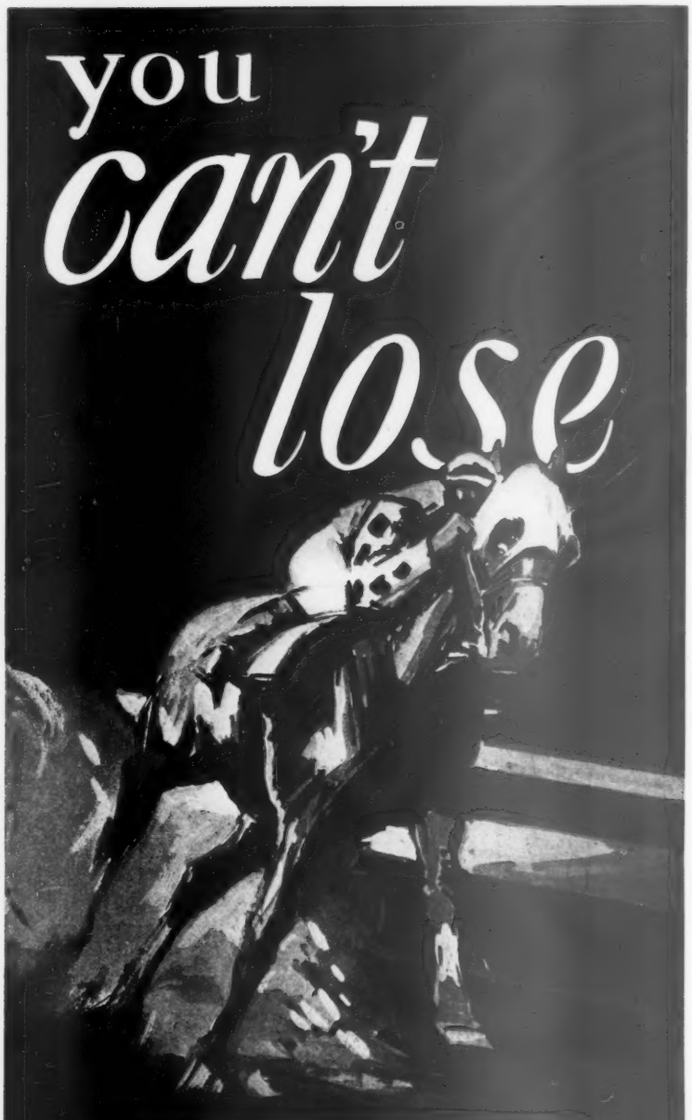
Half a dozen of the leading blocks on the market are minus a lot of friction and plus a lot of smoothness because they run on this special bearing which is built from the inside to the outside, just to give better results in Oil Field service.

See that they are in your blocks in the first place—it saves replacement and saves you from other nuisance.

Standardized by

American Well & Prospecting Co.
Boykin Machinery & Supply Co.
Hopper Machine Company
Latex Iron & Steel Works, Inc.
Lee C. Moore and Company
Lucey Manufacturing Co.
Oil Well Supply Co.
Portable Rotary Rig Co.
Star Drilling Machine Co.

AMERICAN ROLLER BEARING CO.
PITTSBURGH, PENNA.



A 50% Saving or No Pay!

We absolutely guarantee the No-Co-Ro DROP and Seat to outlast and out-perform any *two* Balls and Seats you have ever used—*at the very least.* (As a matter of fact, it is not uncommon for a DROP and Seat to outlast *five* to *thirty-six* balls and seats).

If, therefore, the DROP and Seat *doesn't* give you twice your present service, you pay us nothing; if it does, you effect a 50% to 90% saving in replacement and pulling costs. Either way, you win!

In the interest of permanently lower production costs, give this revolutionary product a trial.

No improvement in recent years has brought about such radical reduction in costs, such overwhelmingly superior performance.

NORRIS BROTHERS, Inc.
Robinson, Illinois and Fort Worth, Texas

Place	Depth	Lbs. Pressure
Cleveland	2,500	800
Cleveland	2,900	1,100
Cleveland	4,500	37
Findlay	950	400–450
Knox Co.	2,700	810
Munroe Co.	1,412	400
Munroe Co.	2,060	735
Newberg	3,000	435
Woodsfield Co.	1,295	280
Woodsfield Co.	1,515	475
Woodsfield Co.	1,468	500
Woodsfield Co.	2,090	710
Oklahoma—		
Bartlesville	1,322	55
California	.....	373
Claremore	860	375
Cleveland	.....	500–700
Cleveland	.....	580
Cleveland	.....	1,280
Collinsville	1,100	477
Collinsville	1,210	490
Copan	.....	440
Cushing	1,600	1,120
Dewey	.....	300
Hogshooter	.....	550
Ponca	500–1,500	375–428
Sapulpa	.....	650
Sobulter	.....	175
Tulsa	.....	525
Pennsylvania—		
Butler Co.	1,200	380
Butler Co.	1,400	780
Butler Co.	1,700	785
Butler Co.	1,452	600
Butler Co.	1,568	225
Butler Co.	1,950	810
Westmoreland Co.	6,822	3,600
West Virginia—		
Barbour Co.	4,090	1,800
Barbour Co.	2,989	1,420
Wyoming—		
Lost Soldier Ferris	2,700	1,000
Texas—		
Mexia	3,000	276
Petrolia	.....	725
Canada—		
Calgary, B. C.	.....	1,200

Assuming that a well has been brought in for an initial production of 2,000 bbls. at a depth of 2,000 feet and at an initial pressure of 700 pounds per square inch, it is possible for 140 cubic feet of gas to be dissolved in every barrel of Oklahoma crude 31 degrees A. P. I. By extending the curve given by Dow and Calkins in United States Bureau of Mines Bulletin No. 2732, February 1926, we can show the decrease in dissolved gas content as the pressure decreases. Tabulation is given below of the quantity of dissolved gas, as well as the quantity of gas required to raise one barrel of oil to the surface under the assumed conditions:

Quantity of Gas That Can be Dissolved in One Barrel of Oklahoma Crude at 31 Degrees A. P. I., and Quantity of Gas Required to Lift One Barrel to the Surface

Assumed Depth	Pressure per Sq. In. Lbs.	Cu. Ft. Dissolved in 1 Bbl. Oil	Ft. Submergence of Oil at 0.9 Specific Gravity	Feet Lift	Cubic Feet of Gas Required to Lift 1 Bbl. to the Surface: At 100 Per cent	Cubic Feet of Gas Required to Lift 1 Bbl. to the Surface: At Obtainable Efficiency	Per cent Dissolved Gas Compared to the Quantity Required
2,000	700	140	1,790	210	8.06	12.40	1,129
2,000	600	120	1,535	465	18.52	29.54	406
2,000	500	98	1,280	720	30.12	51.05	192
2,000	450	88	1,150	850	36.63	65.41	134
2,000	400	78	1,025	975	45.67	89.59	87

Assuming that the well has been properly tubed, the gas that can be dissolved in 1 bbl. of oil at 700 pounds per square inch pressure is 11.29 times the amount required to lift 1 bbl. of oil to the surface. At pressure of 450 pounds the quantity still dissolved in 1 bbl. of oil is slightly greater than that necessary to raise it to the surface, but with a pressure reduced to 400 pounds there is insufficient gas to cause the well to flow steadily and it is probable that the well will begin to flow in "heads," although a fairly continuous flow might result for a further uncertain period if sufficient gas can reach the well from some distance back in the sand. This use of gas, however, would rob the distant oil of its dissolved gas and prevent much of it from flowing through the sands to the well. The time interval between heads results from the necessity of the oil to rise in the well to such a level that the gas accumulated and dissolved in the oil becomes sufficient in quantity and pressure to flow the well for a short period, and after the gas has escaped the fluid level again drops down.

The foot pounds of energy of gas differs somewhat, depending upon the character of the gas. The solubility of different gases varies under pressure; methane and ethane differ somewhat from a perfect gas, and in precise calculations, where the exact composition of the gas is known, allowance would be necessary for this variation. Some of the gases of the paraffin series are changed to a liquid when certain pressures are reached, beyond which point they do not act as gas. However, methane and ethane usually make up about 95 per cent of the total constituents of natural gas.

Mills and Wells[1] have prepared a table of initial pressure in various oil and gas fields at different depths; from this is calculated the average pressure per 100 feet of depth. It seems fair to assume that the initial pressure at all points in the same pool will be practically identical since the time during which the oil was accumulating would tend to equalize the pressure throughout a given pool. This equilibrium is disturbed as soon as a well has perforated the reservoir and gas has been allowed to escape. After several wells have been driven, the pressure throughout the pool will probably show considerable variation. In some cases, pressures above the equivalent hydrostatic pressure of 0.43 pound per square inch per foot of depth are found, while in many others lower pressures obtain. In the main, a pressure of 0.35 to 0.40 pound per square inch per foot of depth is rather usual, and in calculations where initial pressures are not known 0.35 pound per square inch per foot of depth can be used.

The possibility of lifting all, or at least a large part of the oil in a pool by means of the gas associated with the oil may be visualized by reference to the figures given in Table No. 9, which apply to several of the large oil fields in the United States.

Gas-Oil Ratios

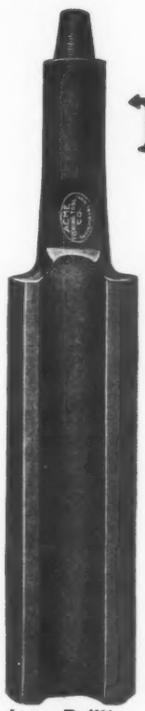
The gas-oil ratio, or gas-factor as it has sometimes been termed, is the volume-ratio existing between the gas and the oil which it accompanies from the producing formation; it is expressed in cubic feet of gas at atmospheric pressure per barrel of oil produced. The term was first employed in a published article by T. E. Swigart, if I mistake not, who wrote a paper on this subject February 27, 1925. I am informed that this term was employed at an earlier date by engineers of the United States Bureau of Mines in their reports.

The gas-oil ratio takes into account only the gas associated with the oil; the efficiency factor refers to the lifting efficiency obtained whether it be in a well flowing naturally or whether it be one flowed by means of the air or gas lift. Where compressed air or gas is admitted to the well the term "gas-lift factor" might be employed to distinguish between the gas associated with the oil, and the total gas employed in lifting the oil. The unit volume of liquid may be either the gallon or the barrel; the unit volume of gas is usually taken as 1 cubic foot at atmospheric pressure, which is usually based on 14.7 pounds per square inch. In a flowing well the gas-oil ratio and the "gas-lift factor" would, of course, be identical. The efficiency factor is obtained by dividing the foot pounds of work performed in lifting a unit volume of liquid to a given height by the foot pounds of work that would be performed by a unit volume of gas in expanding from the pressure under which it is compressed to the lower pressure at which the liquid is discharged. In the case of a well flowing naturally the gas-oil ratio becomes one of the important factors on which the efficiency is based.

Some instances of gas-oil ratios in flowing wells are noted in Table No. 10.

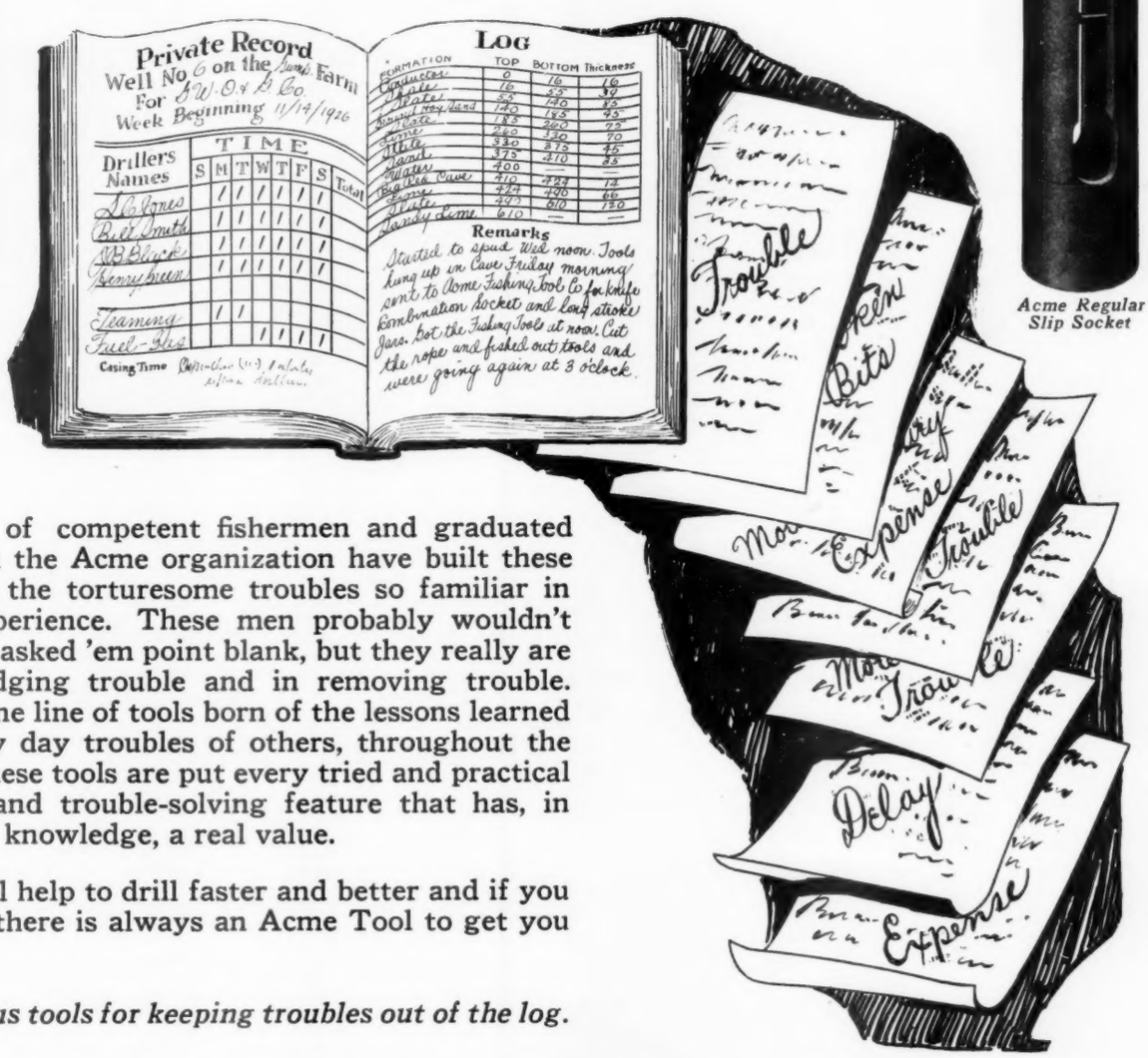
[1]R. V. A. Mills and R. C. Wells, "The Evaporation and Concentration of Waters Associated With Petroleum and Natural Gas." U. S. Geological Survey. Bull. 693.

ACME
DRILLING and FISHING TOOLS
Take Countless Troubles out of the Log



Acme Drilling Bit—Mother Hubbard Pattern

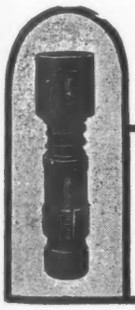
Acme Regular Slip Socket


Private Record
Well No 6 on the Land Farm
For J.W.O.& G. Co.
Week Beginning 11/14/1926
TIME
Drillers Names
S M T W T F S Total
Casing Time
LOG
FORMATION TOP BOTTOM Thickness
Remarks
Started to spud Wed noon. Tools hung up in Cave Friday morning sent to Acme Fishing Tool Co for knife Combination Socket and Lead stroke Jars. Got the Fishing Tools at noon. Cut the rope and fished out tools and were going again at 3 o'clock.
Trouble
Bits
Expense
Trouble
Delay
Expense

THE staff of competent fishermen and graduated drillers in the Acme organization have built these tools to avoid the torturesome troubles so familiar in their wide experience. These men probably wouldn't admit it if you asked 'em point blank, but they really are experts in dodging trouble and in removing trouble. They build a fine line of tools born of the lessons learned from the every day troubles of others, throughout the country. In these tools are put every tried and practical trouble-proof and trouble-solving feature that has, in their thorough knowledge, a real value.

Acme tools will help to drill faster and better and if you are in trouble there is always an Acme Tool to get you out quickly.

They are famous tools for keeping troubles out of the log.



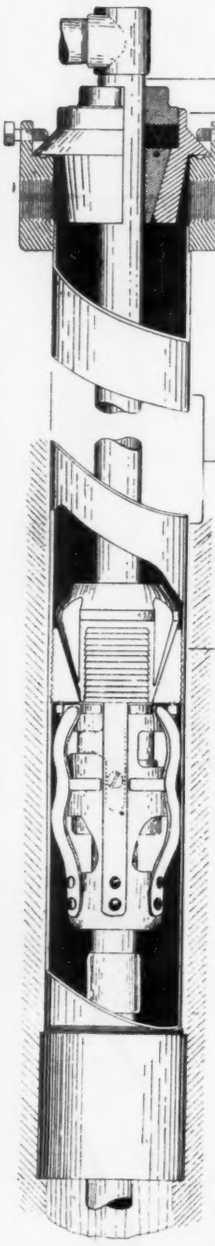
ACME FISHING TOOL CO.
Parkersburg, West Virginia.

Export Office: 136 Liberty St., New York City, N.Y.

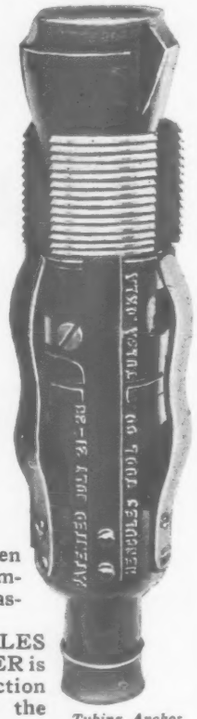
Warehouses and Distributors:

Acme Fishing Tool Company—Parkersburg, W. Va.
Acme Fishing Tool Company—Omulgee, Okla.
B. & A. Specialty Company—Tulsa, Okla.
Acme Fishing Tool Co. of Tex.—Whittenburg, Tex.
Acme Fishing Tool Co. of Tex.—Roxana, Texas.
Acme Rental Tool Service Company—Graham, Tex.
Acme Tool Co.—Breckenridge, Tex.
Acme Tool Co.—Albany, Texas.
Acme Tool Co.—Brownwood, Texas.
Acme Tool Co.—Cross Plains, Tex.
Acme Tool Co.—Fry, Texas.
Acme Tool Co.—McCamey, Texas.
Midland Iron Works—Billings, Montana.
Great Northern Tool & Supply Co—Kevin, Montana.
Great Northern Tool & Supply Co.—Kemmerer, Wyo.
Elms Brothers & Company—Waynesburg, Penna.
Lloyd, Smith Company—Bradford, Penna.
Logan Foundry & Machine Company—Logan, Ohio.

The Hercules Team That Protects The Tubing Against All Accidents While In The Well



TUBING IS POSITIVELY PROTECTED from parting or dropping in the well when equipped with a HERCULES TUBING ANCHOR. The Anchor can be placed at any desired point within the casing and can always be controlled at the casinghead. When used in a pumping well tubing accidents are eliminated. The Anchor is always set and the tubing cannot drop. Should the tubing part when pulling it would simply stop in the casing.



Tubing Anchor (Patented)

Where a HERCULES TUBING HANGER is used in conjunction with an Anchor the tubing has the maximum of protection, being protected at both the top and bottom of the well.

The Hanger has adjustable packing features and will hold any pressure where gas or air is used to flow the well. It has three slips which grip entirely around the tubing, is made of forge steel and will support many times the weight of the longest string of tubing.

Tubing Hanger (Patent Pend.)

Send for descriptive literature.

For sale by all leading supply houses.

Manufactured and sold by

HERCULES TOOL TULSA

Hercules Tool Company

Tulsa, Oklahoma

Phone 3-2358 P. O. Box 286 507-8 Bliss Bldg.

TABLE NO. 9

Field	Depth of oil sand, feet	Initial pressures, lb. per sq. in.	Oil submergence corresponding to initial pressure, feet	Lift, in feet	Specific gravity of oil	Gas required to raise 1 gal., making no allowance for friction loss, cu. ft.	Absorbed gas per gal. of oil based on projection of Dow and Reiss curve, cu. ft.	Ratio of absorbed gas to quantity theoretically required to raise 1 gal. of oil
Burbank, Okla.	2,950	800	2,202	748	0.837	0.615	4.88	79
Caddo, La.	3,623	1,200	4,262	....	0.85	....	7.53	..
Caddo, La.	1,650	650	1,687	....	0.876	....	3.62	..
Calgary, Canada	3,740	1,200	4,000	....	0.692	....	7.53	..
Cotton Valley, La.	2,556	900	2,363	193	0.876	0.161	5.1	32
Cushing, Okla.	2,092	725	2,000	92	0.835	0.075	4.33	58
Dominguez Hill, Calif.	4,200	1,470	3,814	386	0.868	0.286	9.52	33
Dominguez Hill, Calif.	4,223	820	2,176	1.539	0.868	1.302	4.89	3.7
Mirando City, Tex.	1,944	635	1,581	363	0.925	0.378	3.8	10.5
Rosecrans, Calif.	4,125	1,444	3,994	131	0.833	0.094	9.0	9.6
Rosecrans, Calif.	4,125	800	2,212	1.913	0.833	1.561	4.88	3.1
Smackover, Ark.	2,200	900	2,091	109	0.922	0.0987	5.1	52
Wellington, Colo.	4,285	1,400	3,790	494	0.850	0.386	8.8	22.8
Westmoreland, Pa.	6,822	3,600	8,294	1.472	....	....	....	....
Lost Soldier, Wyo.	2,700	1,000	2,643	57	0.867	0.046	6.2	134.8

TABLE NO. 10

Field—	Bbl. oil per day	Gas-Oil Ratio
Brock, Okla.	950	1,220
Brock, Okla.	1,200	1,160
Brock, Okla.	350	1,320
Cromwell, Okla.	....	2,800
Cromwell, Okla.	....	5,900
Dominguez, Calif.	1,385	650
Dominguez, Calif.	392	1,775
Dominguez, Calif.	2,218	633
Dominguez, Calif.	741	2,290
Salt Creek, Wyo.	152	1,000
Salt Creek, Wyo.	134	1,500
Stroud, Okla.	....	3,000
Stroud, Okla.	....	4,000
Tonkawa, Okla.	1,518	2,120
Tonkawa, Okla.	4,780	3,010

Instances of gas-oil ratios in pumping wells are noted in Table No. 11.

TABLE NO. 11

Field—	Gas-Oil Ratio
Haynesville, La.	400 to 200
Drumright, Okla.	2,900 to 5,980
March, Okla.	2,700 to 4,700
Monroe County, Ohio	4,000 to 1,400
Monroe County, Ohio	5,400 to 23,500
Muskogee, Okla.	3,900
Muskogee, Okla.	6,800

A comparison of the figures in Tables 10 and 11, would appear to indicate that pumping wells usually furnish a higher gas-oil ratio than flowing wells. It would be well worth the effort for a large number of operators to compile data on gas-oil ratios both for pumping wells and flowing wells.

Efficiency Factor in Relation to Gas-Oil Ratios in Flowing Wells

In order to ascertain the efficiency with which the energy stored in the gas is being employed, it is necessary to have not only the gas-oil ratio in wells flowing by means of compressed air or gas, but also the pressure in the well opposite the producing sand, the depth from the surface to this point, the gravity of the liquid being lifted, and the analysis of the gas, although the last-mentioned factor may be omitted in many cases with no serious error in calculations especially where pressures are as low as 100 to 200 pounds per square inch.

Examples of flowing wells with related data are given in Table No. 12 to show the distinction between the gas-oil ratio and the efficiency obtained:

Efficiencies in the above instances are less than 10 per cent with one exception, of Dominguez, Calif., where 16.6 per cent was obtained by the use of the bean to restrict the uncontrolled flow of the gas. After the flush pressure was off at Dominguez the bean resulted in low efficiency. At Tonkawa the efficiency at 1 per cent is very low, but the quantity of gas dissolved in a barrel of oil under 1,200 pounds pressure is approximately 245 cubic feet per barrel, while the quantity required to lift a barrel of oil at 100 per cent efficiency is only 22.4 cubic feet. Under these conditions the highest efficiency possible to obtain would be 22.4÷245, or 9.1 per cent.

Efficiencies of wells flowed by means of the gas lift are given in Table No. 13.

Example Nos. 8, 9, and 10 are those of wells that were equipped with the writer's method of using the gas lift, where a scientific design of gas lift is worked out for tubing the wells and for operating them.

Many oil wells have been flowed with air but in no instance of which I am aware have meters been placed on the discharge air-gas line, and therefore no data are available on the gas-oil ratio, or gas-lift factors when using compressed air for flowing the wells.

Efficiencies

Efficiencies are dependent upon designs of footpiece, flow tubing, and discharge arrangements, and these are in turn dependent upon conditions existing at the well. Improper sizes of pipe, right angle turns and horizontal flows all tend to reduce the efficiency. In very shallow wells where fairly high percentage of submergence is available, as high as 70 per cent efficiency is possible to obtain, while in wells 4,000 feet in depth with submergence pressure of 200 pounds per square inch, 30 per cent efficiency would be very high. In general it may be said that efficiencies as low as one-half the percentage of submergence should never be accepted, while efficiencies as high as the percentage of submergence indicate very good work.

Gas-Oil Ratios Resulting From Back Pressures

In some instances back pressures on oil wells brought about by the use of beans, chokes, etc., have resulted in fairly low gas-oil ratios; the best examples that have been made public are those of the Shell Oil Co. of California of which a table was included by T. E. Swigart in a paper read before one of the technical societies in Los Angeles, Calif., about two years ago, describing operations in the Dominguez Field, California. A list of back pressure gas-oil ratios was also given by John M. Lovejoy for the Brock Field, Oklahoma, in a paper read before the American Institute of Mining and Metallurgical Engineers in 1923. A discussion of gas-oil ratios noted

TABLE NO. 12

Field—	Gas-Oil Ratio	Depth Feet	Pres. lbs. per sq. in.	Sp. grav. of the oil	Pct. Efficiency
Brock, Okla.	1,160	2,000	300	*0.85	4.0
Dominguez, Calif.	605	3,610	410	0.88	16.6
Dominguez, Calif.	1,775	3,610	250	0.88	3.1
Salt Creek, Wyo.	1,000	*2,200	520	0.85	3.1
Tonkawa, Okla.	2,120	4,100	*1,200	0.82	1.0

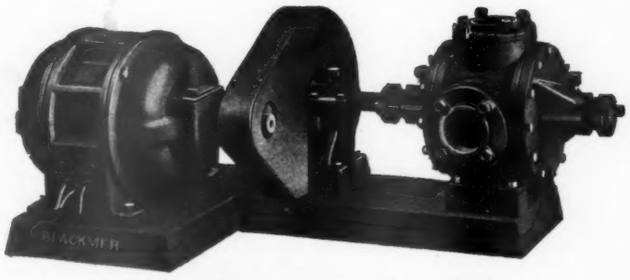
*Assumed figures.

TABLE NO. 13

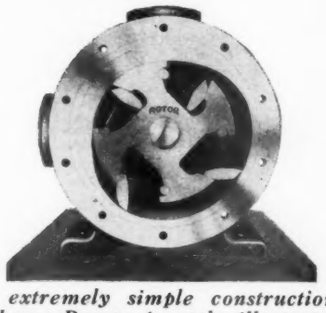
No.	Field—	Gas-Oil Ratio	Gas Added	Gas-Lift Factor	Depth Feet	Pres. Lbs.sq.in.	Spe. Grav.	Pct. Efficiency
1.	California	1,059	630	1,689	4,231	120	0.865	11.9
2.	California	227	1,783	2,000	3,880	155	0.892	9.3
3.	California	1,577	2,143	3,720	4,182	130	0.876	6.5
4.	Dominguez, Calif.	1,100	1,200	2,300	3,610	260	0.876	7.2
5.	Huntington Beach	928	2,222	3,150	4,519	280	0.9	6.0
6.	Santa Fe Springs	611	466	1,077	3,700	195	0.87	14.8
7.	Seminole, Okla.	490	310	800	3,880	500	0.82	12.6
8.	Seminole, Okla.	540	606	1,146	3,990	136	0.82	18.6
9.	Tonkawa, Okla.	667	222	889	4,100	250	0.82	18.0
10.	Tonkawa, Okla.	377	445	822	4,100	250	0.82	21.4

BLACKMER ROTARY PUMPS

Take up their own wear automatically



Blackmer Single Electric Unit. Built in various sizes from 1 to 500 g.p.m.



The extremely simple construction of Blackmer Pumps is aptly illustrated in this view, taken with the head of the pump removed.

On the basis of past performance alone, Blackmer Pumps deserve your consideration.

Their remarkable ability to establish new records for low cost pumping is largely due to the automatic-take-up-for-wear design. This basic design remains the same today as it was in the first Blackmer Pump ever built. Now, with the years of experience have come refinements of design and construction which place Blackmer in a dominating position in the rotary pump field.

New economy in manufacture has been gained through more adequate factories and the saving has been passed on to the user.

The present pump is honestly "better than ever." It will pay you to investigate and get complete data on the present Blackmer line. Your inquiry will receive careful attention. Write

More Gallons Per Dollar

BLACKMER PUMP CO.

1809 Century Ave. **Grand Rapids, Mich.**

Offices in 20 Principal Cities

Hard Jobs Made Soft!

ALWAYS ready for a hundred and one jobs of lifting and conveying! Always ready to be moved here, there, anywhere they are needed! Always on the job and always doing the job quickly, easily and safely!

That's a brief, snappy explanation of what you get when you sign up "Matchless" Trolleys, "Cyclone" Hoists, and "Matchless" Derrick Cranes.

Ask Your Jobber

about the exclusive *GYRATING* principle of operation of "Cyclone" Hoists; the free and easy operation of "Matchless" Trolleys made possible by the patented and exclusive FLANGELESS WHEELS and other features; and the exceptional construction of "Matchless" Derrick Cranes which, for brute strength, are "Matchless" in *fact* as well as in name.

Get acquainted with these rugged, "built for service" material handlers. You'll know what we mean when they start working for YOU!

THE CHISHOLM-MOORE MANUFACTURING CO.
Main Office & Factory—Cleveland, Ohio
All Leading Oil Supply Jobbers Stock
"C-M" Overhead Material Handling Equipment

CHISHOLM-MOORE
OVERHEAD HOISTS CRANES TROLLEYS TRACK SYSTEMS

in these papers may be of interest.

The following table, No. 14, gives a selected list of the gas-oil ratios obtained at Dominguez:

TABLE NO. 14

Well	Cas. Pres. Lbs.	Tubing Pres. or Back Pres. Lbs.	Feet Submergence Sp.Grav. Oil at 0.88	Lift in Ft.	Gas-Oil Ratio	Pct. Efficiency	Cu.ft. Gas Dissolved in 1 bbl. Oil at Cas. Pres.
A	410	140	1,074	2,537	650	16.6	77
A	360	190	942	2,669	1,487	8.0	69
A	270	140	707	2,904	1,570	8.8	48
A	250	125	655	2,956	1,775	8.1	44
B	620	200	1,611	1,949	503	14.2	120
B	890	190	2,331	1,329	706	7.1	175
B	800	180	2,094	1,566	895	6.2	156
B	650	170	1,700	1,960	1,032	7.0	126
C	500	150	1,310	2,478	560	17.5	95
C	480	190	1,257	2,531	863	11.8	91
C	370	150	968	2,820	829	14.7	69
D	600	160	1,570	2,164	370	22.1	115
D	560	180	1,466	2,268	606	14.2	108
D	460	220	1,204	2,530	885	11.6	87
E	700	..	1,833	1,882	315	21.6	135
E	690	230	1,807	1,908	822	8.0	134
E	580	225	1,518	2,197	1,145	7.3	111
F	510	130	1,335	2,420	409	23.1	97
F	460	150	1,204	2,551	725	14.3	87
F	410	145	1,074	2,681	1,035	10.7	77
G	480	130	1,257	2,293	633	14.6	91
G	300	110	785	2,765	1,628	7.7	54
G	225	100	590	2,960	2,290	6.0	39
S	650	160	1,700	1,901	473	14.9	126
S	560	175	1,466	2,135	653	12.6	108
T	880	145	2,302	1,435	338	14.7	172
T	770	170	2,016	1,721	527	11.6	150
U	1,025	450	2,700	1,034	462	7.5	200
U	975	170	2,554	1,180	610	6.5	190

It will be noted that the gas-oil ratios are usually rather low for each well at the period of high pressure, particularly where the tubing pressure is low. At the time of high pressure, the theoretical fluid level, or submergence, is high and the lift is comparatively low. The work to be done in lifting the oil is at the low point and the efficiency is considerably higher than at succeeding stages, in fact, is almost as high as can be secured by means of the gas lift. However, as lower pressures are reached it will be seen that the gas-oil ratio rapidly increases and the efficiency factor is lowered. It would therefore appear that back pressures of this nature are beneficial in the very early stages of flowing conditions but in a comparatively short time the efficiency falls to an unacceptable point, and the gas-oil ratio mounts to a figure that is much beyond the 500 cubic feet per barrel of oil that has been proposed as a standard figure. It appears that 500 cubic feet is seldom attained when employing back pressures even under the most favorable conditions, and never approached in the later stages.

Gas-oil ratios obtained in the Brock Field by the Amerada Petroleum Corp. are shown in Table No. 15. These ratios are not at all high as compared with the usual run of gas-oil ratios obtained under similar conditions, and yet none of them approach 500 cubic feet per barrel of oil.

TABLE NO. 15
Gas Oil Ratios Obtained in the Brock Field Using Back Pressures

Period—	Average back Pressure	Total oil produced bbl.	Total gas volume cu. ft.	Gas-Oil Ratio	Per Cent Efficiency
Jan. 1-6	12	950	1,150,000	1,220	5.8
Jan. 16-21	15	975	1,150,000	1,220	5.8
Jan. 26-31	0	925	1,300,000	1,300	5.4
Feb. 10-15	0	1,200	1,375,000	1,160	6.1
Apr. 1-6	32	1,100	1,500,000	1,360	5.2
May 6-11	0	1,160	1,320,000	1,070	6.6
June 20-25	0	1,005	1,275,000	1,270	5.6
July 10-15	76	510	850,000	1,620	4.4
Aug. 19-24	48	500	720,000	1,400	5.1
Sept. 13-18	49	350	490,000	1,320	5.4
Sept. 1-20	0	551	554,500	1,006	7.6
Sept. 21-25	50	155	129,405	834	8.5

TABLE NO. 16

Field—	No. of wells	Avg. bbls. per well per day	Total bbls. per day
Dominguez	28	314	8,792
Huntington Beach	36	346	12,456
Long Beach	35	296	10,360
Rosecrans	54	98	5,292
Santa Fe Springs	45	281	12,645
Torrance	17	74	1,258
Total	215	236	50,803

Low gas-oil ratios are obtainable by means of efficiently-designed air and gas lifts, practically from the beginning of flowing conditions, and control of the gas-oil ratio can be continued well along through the life of the well, but the exact gas-oil ratio is not one to which a value can be arbitrarily assigned. It must be left to the engineer to work out the most practicable gas-oil ratio that can be obtained for a given well. At Seminole, where we are now working on this problem, ratios in offsetting wells are found to vary by large amounts, apparently without any clear explanation that can be given at this time, although there is, of course, a reason for same not yet apparent.

Gas Lift Practice

Some examples of gas lifts in various fields will be of interest in indicating the importance that this method has assumed in the production of oil. In December 1926, the following summary was given of oil wells in the Los Angeles Basin which were being operated by gas lifts:

A summary of wells on gas lift in the Seminole Field as of February 15, has been given as follows:

No. of Wells	Average Bbls. per well per day	Total Bbls. per day
87	1,765	153,587

On March 13, 1927, the production of The Carter company alone, from air and gas lifts in the Seminole Field was as follows:

No of Wells	Average Bbls. per well per day	Total Bbls. per day
22	2,265	49,840

It will be noted that gas and air lift production in Seminole and in the Los Angeles Basin accounts for nearly 10 per cent of all of the oil produced in the United States.

Details of Operating Arrangements

Data on the operations of air and gas lifts in various fields is given in Table No. 17.

Important data in connection with operating gas lifts in California are given in a paper written by R. P. McLaughlin for the American Institute of Mining & Metallurgical Engineers at the Tulsa meeting in October 1926, are noted in Table No. 18.

In May, 1926, the writer was engaged by the Roxana Petroleum Corp. to work out some of the problems connected with wells of that company at Tonkawa. Braman and Garber, and various phases of the methods employed by the writer were installed in several wells. *The results of the use of this method were, as a whole, quite satisfactory, so far as it was possible to carry out these ideas in a limited time. A total of 14 wells producing 6,590 bbls. per day before installation of the air lift were increased to 13,847 bbls. afterward, thus giving an increase of 110 per cent. The range of increase was from 5 to 400 per cent where conditions were favorable for the use of the air lift, indicating that in many cases wells would yield a greater production of oil if the liquid were removed as rapidly as it enters the well. Most of this increase was made on wells already provided with the usual type of gas lift.

In bringing about this change in operating conditions it was arranged to remove all back pressures wherever possible. All pockets where air or gas could accumulate, and all horizontal flows were

* Paper read before American Institute of Mining & Metallurgical Engineers, Tulsa meeting, Oct., 1927.

This Is the Way We LOOKED in Jarecki's Early Days

CELEBRATING our Diamond Anniversary, what could be more appropriate than a display of a page from our "family album?"

Here we have a picture of our Bradford, Penna., store, taken in 1888. Reading from left to right, the handsome group comprises Frank Robinson, James H. Field, Lewis Byers, Frank A. Griffin, J. W. Griffin, Scott Watson, W. Matt Star, E. A. Weart.

Stores, styles and equipment have seen many changes since the camera shutter closed on this scene, but the simple principle of conscientious service remains the same. In 1927 as in 1852, it is the guiding principle of this organization.

Jarecki Cast-Iron Working Barrel

Close-grained, free from impurities, glassy smooth on the inside and absolutely true throughout. A single organization has over 15,000 in use! At your nearest Jarecki store.

Jarecki

MANUFACTURING COMPANY

Home Office and Factory—Erie, Pa., U. S. A.

General Office, St. Louis, Mo.

Branch stores at all important places in the Oil Country.

District Offices { Pittsburgh, Pa.; El Dorado, Kan.; Tulsa, Okla.; Newark, Ohio; Eastland and Dallas, Texas; Lawrenceville, Ill.

PATRICK CARBON
for Diamond Core Drilling

"Specify Patrick Carbon"

PATRICK ideals in buying and grading carbon are as practical as they are sound. An increasing demand for this service is an outstanding tribute to the Policy, that, the customer *must* be satisfied.

SEND FOR BOOKLET

You can get in touch with our representative by wiring Duluth office

R. S. PATRICK
Duluth, Minnesota, U.S.A.
Cable Address, "Exploring" Duluth

TRIBLOC *Chain Hoists*

Costs more to make costs less to use

This hand chain Guide is always painted GREEN

IT is always painted GREEN for two reasons.

One is that it identifies a chain hoist unequaled for long, hard service on almost any sort of a job. Another reason is that it indicates what is probably the most important protective feature of any chain hoist made—the LOOP HAND CHAIN GUIDE.

This Guide, owned and used by ourselves and licensed for use on but few other chain hoists, is the only Guide that absolutely controls the hand chain while in motion. It prevents the hand chain from buckling or "gagging" in the guide—whether operated at the point of hoisting or at an angle from the hoist.

It has many other advantages about which we should like to tell you. Send for Catalog 7-B.

FORD CHAIN BLOCK COMPANY
Second and Diamond Sts., Philadelphia, Pa.

TABLE NO. 17

	Evangeline, La.	Evangeline, La.	Baku, Russia	Currie, Texas	Currie, Texas	Kern River	West Columbia	West Columbia
	1	2	3	4	5	6	7	8
Lift in feet	1,135.5	895	770	256	624	407	550	485
Submergence in feet	377.5	597	694	1,244	876	330	743	1,096
Total length in feet	1,513	1,492	1,464	1,500	1,500	800	1,299	1,581
Per cent submergence	26	40	47.4	82.9	58.4	41.2	57.6	69.3
Depth of well in feet	1,805	1,900	.....	2,900	2,900	.....	3,000	3,000
Diameter casing, inches	6	6	4	6⅝	6⅝	.....	.....	.....
Diameter flow pipe, in.	4	4	4	6⅝	6⅝	3	4	4½
Diameter air pipe, in.	.....	1¼	2½	2½	2½	1¼	2	2
Gallons fluid per min.	22	45.2	46.9	119.5	81.4	92	73	102
Weight fluid per gal.	8.7	8.72	.....	.....	.....	.....	.....	.....
Lbs. pressure at inlet	249	259	312	540	380	143	325	475
Total cu. ft. air	573.5	326	150	.....	.....	140	246	240
Cu. ft. air per gal.	17.92	7.21	3.2	2.0	3.06	1.5	3.37	2.33
Cu. ft. required at 100% efficiency	2.061	1.207	0.99	0.277	0.766	0.788	0.69	0.526
Per cent pumping efficiency	11.5	16.8	32.3	13.8	25.0	53.5	20.5	23.0

TABLE NO. 18

Working Data and Operating Results at Eight California Wells in Various Fields

Well No.	Age of Well, Mo.	Daily Production, Bbl. Initial	Before Gas Lift	After Gas Lift	Depth, Ft.	Formation Exposed (Perforated), Ft.	Diameter Cas. (Oil String), In.	Diameter Tubing, In.	Depth to Gas Inlet, Ft.	Foot Place (Yes or No)	Gas Down (through Casing or Tubing	Starting Pressure, Lbs.
1	18	1,040	400	955	4,939	980	6	2⅜	3,790	Yes	C	540
2	19	6,000	296	610	4,638	186	4½	2⅜	4,357	Yes	C	360
3	36	3,000	300	380	4,231	235	4½	3	3,368	No	C	.....
4	30	800	220	420	3,880	62	6¼	2½	3,500	No	C	.....
5	21	1,375	215	350	4,182	380	6¼	2½	4,142	No	C	310
6	5	250	150	200	4,790	1,387	6¼	3	3,917	No	C	400
7	49	2,800	260	360	3,510	857	6¼	2½	3,125	Yes	C	500
8	38	3,000	500	550	5,251	2,050	5 3/16	2¼	3,524	Yes	C	550

Well No.	Working Pressure	Viscosity of Oil* (Sec.)	Gas in, M.C.F.	Gas out, M.C.F.	Water, Per Cent	Gravity of Oil, Be.	Total Gas Per Bbl. of Oil, Cu. Ft.	Lift (Working), Ft.	Submergence, Ft.	Ratio—Lift / Submergence
1	400	89	....	426	2	28	445	2,690	1,100	2.45
2	310	44	....	274	2	35	433	3,501	856	2.47
3	120	....	239	639	0.2	32	1,680	3,024	344	8.73
4	155	62	749	839	12.0	29	2,000	3,056	444	6.81
5	130	58	750	1,300	0.1	30	3,720	3,768	374	9.94
6	100	80	500	750	0.1	27	3,750	3,631	286	12.7
7	250	120	300	650	1.0	25	1,860	2,401	715	3.35
8	300	120	250	400	0.2	25	727	2,646	953	2.97

* Saybolt—100° F.

TABLE 19—Gas-Control Data on Two Wells in Mid-Continentent Field

Well	Period	Oil per Day, Bbl.	Pressure Gage, Lib.	Gas per Bbl. Oil: From Compressors, Cu. Ft.	From Sands, Cu. Ft.	Total, Cu. Ft.	Volume Gas at 100 per ct. Efficiency, cu. ft.	Efficiency, Per Cent
1	May 19 to 28	1,433	250	261	939	1,200	154.67	12.9
1	May 29 to June 7	1,619	250	345	853	1,198	160.14	13.4
1	June 8 to 17	2,128	250	261	699	915	156.95	17.2
1	June 18 to 24	2,497	250	222	667	889	160.14	18.0
2	July 1 to 10	404	250	606	438	1,044	149.48	14.3
2	July 11 to 17	829	250	745	663	1,408	160.40	12.8
2	July 18 to 24	1,891	250	520	473	993	184.63	18.6
2	July 25 to 30	1,994	250	445	377	822	176.44	21.4

eliminated, so far as practicable, the gas trap being moved close to the well and placed at such an elevation that a gravity line would carry the liquid from the trap to the receiving tank. The flow column, or eductor, was of such design at the lower end as would reduce to a minimum the slippage loss that usually takes place in the lower section of the eductor pipe, and the upper section so designed as to reduce the friction loss in that part to an acceptable minimum. Finally, and not the least important, the wells were operated at the rate that gave the highest acceptable efficiency for the particular set of conditions involved.

Orifice meters were placed on both the gas-input line and the gas-discharge line of some of the wells in order to determine the quantities of gas consumed per barrel of oil during the operation. The readings on the input meter charts were fairly satisfactory, but in some cases where the discharge fluctuated to some extent the oscillations of the differential pressure pen are rather severe and the readings were not as accurate as could have been desired, this condition making for some apparent discrepancies. However, the general tendencies afford some valuable information on control of the gas accompanying the oil, as will be noted in Table No. 19, which gives data on two of these wells.

It will be noted that at Well No. 1 there was, in general, a decrease in consumption of gas per barrel of oil lifted as the quantity lifted more nearly approached the efficient capacity of the eductor. The gas accompanying the oil from the sand showed a gradual decrease per barrel of oil, dropping from 939 cubic feet to 667 cubic feet per barrel, and in Well No. 2 the quantity of gas was reduced to 377 cubic feet per barrel. The quantities of 667 and 377 cubic feet can be still further reduced by closed design to meet the exact conditions. In a paper read before the Federal Oil Conservation Board on February 10, and 11, 1926, James O. Lewis estimated that the quantity of gas accompanying a barrel of oil taken as an average in all classes of wells is about 1,500 cubic feet. G. O. Smith states that at Dominguez the input gas under 260 pounds pressure averages about 1,100 cubic feet per barrel of oil, which with the 1,200 cubic feet accompanying the oil makes a total of 2,300 cubic feet required to lift a barrel of oil to the surface, and this is compared with the natural ratio of 2,850 cubic feet per barrel for that field.

The gas-oil ratios in Tables No. 19 are about as satisfactory as can be obtained under similar conditions. Comparisons of gas-oil ratios obtained by use of beans at Dominguez with the figures obtained at Tonkawa in Table No. 19, together with the data obtaining for gas-lift wells at Dominguez, are found in Table No. 20.

At the present time, gas lift practice in the Panhandle and in Seminole is commanding considerable attention. "Examples of wells in the Panhandle and in Seminole illustrate the use of submergence, lift and efficiency. In paper presented before the American Institute of Mining & Metallurgical Engineers at the February meeting of 1927 by E. O. Bennett and K. C. Sclater, depths of wells in the Panhandle are given as about 3,000 feet; tubing lengths about 2,400 feet; working pressures 160 pounds per

Steel Plate Construction

Economically and Rapidly Fabricated

Thomas Multiple Punch Press

Towering presses, giant rolls, huge equipment—all the enormous machinery of a modern plant completely equipped to give quantity production of heavy steel plate construction are so placed in the P. I. W. shops as to give high efficiency and low manufacturing costs.

P.I.W. STEEL PLATE CONSTRUCTION

The advantages of this equipment to buyers of steel plate construction are not only the certainty of well made products, but also the assurance of prompt fabrication and rapid delivery.

With the special need of the oil industry for rapid construction, the ability of the P. I. W. shops to meet this demand without sacrificing quality is of prime importance.

Branch Plant: Beaumont, Texas

Bull Riveter

1500 Ton Hydraulic Press

Bending Rolls

THE PETROLEUM IRON WORKS COMPANY

NEW YORK CHICAGO SHARON, PA. HOUSTON TULSA

P.I.W. SERVICE IS WORLD-WIDE

OTHER "PENBERTHY" PRODUCTS

Ejectors
Cellar Drainers
Oil Gages
Water Gages
Oil Cups
Grease Cups, Etc.

PENBERTHY PRODUCTS

Special High Pressure Automatic Injector

Owing to the increasing demand in the oil fields for injectors to operate on higher pressures, this high pressure injector is recommended where boilers are operated at pressures to 200 pounds.

Write For Catalog

PENBERTHY INJECTOR COMPANY
Established 1886
Canadian Plant: WINDSOR, ONT., CAN.
1260 Holden Ave., DETROIT, MICH.

"A REAL OIL COUNTRY BELT"

O AND G

OIL GAS

Pumping—Drilling — Compressor
Double-Stitched

BELTS

RUGGED — DURABLE

Built to successfully withstand the hardest oil field service—growing in popularity daily

Manufactured by

IMPERIAL BELTING CO., Chicago

Sold by

OIL WELL SUPPLY CO.

In All Fields

TABLE 20—Comparison of Oil-well Gas-control Data

Well No.	Gas per Bbl. Oil, Cu. Ft. Input.	Gas per Bbl. Oil, from Sand, cu.ft.	Gas per Bbl. Oil, Cu. Ft. Total.	Gas Dissolved in Oil, Cu. Ft. per Bbl.	Gas, Abstracted from Oil Not Lifted, to Lift 1 Bbl. Oil, Cu. Ft.	Saving over Natural Ratio of 2,850 Cu. Ft. per Bbl. Oil, Cu. Ft.	Oil That Can be Moved to Well by Gas Saved, Bbl.
A	.....	1,775	1,775	44	1,731	1,075	0.6
G	.....	2,290	2,290	39	2,251	560	0.25
Domingues.	1,100	1,200	2,300	44	1,156	1,650	1.38
1	222	667	889	44	623	2,183	3.27
2	445	337	822	44	333	2,473	7.42

TABLE NO. 21
Data on Air and Gas Lift Wells in the Panhandle and in Seminole

Field—	Working Pressure of Submergence	Specific Gravity of the oil	Feet Submergence	Length of Air Line	Feet Lift	Gas Lift Factor or Cu. Ft. Gas Consumed per Bbl.	Quantity Required at 100%	Per Cent. Efficiency Obtained
Panhandle	160	0.85	434	2,400	1,966	1,000	112.0	11.2
Seminole	160	0.82	450	3,968	3,518	915.6	192.8	21.1

square inch; gas-lift factor, 1,000; and I am assuming the oil to have a specific gravity of approximately 0.85. The submergence for water at 160 pounds would be 368.6 feet and for oil at 0.85 specific gravity would be 434 feet. The lift would then be 2,400 minimum 434, or 1,966 feet. The quantity of air at 100 per cent efficiency to raise 1 bbl. of oil of specific gravity of 0.85 to a height of 1,966 feet under submergence pressure of 160 pounds would be 112.0 cubic feet. The efficiency obtained is then 112 divided by 1,000, or 11.2 per cent. An example of a well in Seminole on which data were recently observed, calculated in the same manner as for the Panhandle is noted in the accompanying table, No. 21.

Method of Pipe Arrangement

The general arrangement that the writer has employed for applying the use of compressed gas and air for lifting oil is shown in Figure 3. It will be noted that in pipes where the gas is mixed with the oil all right angle turns are eliminated so far as possible, and all down turns are eliminated in which gas pockets could form. Figure No. 4 illustrates the general arrangement found of service when the Type No. 2 (Figure 2) of lift is employed for lifting the oil. This arrangement is employed for large wells of considerable depth, that is, for 1,000 bbls. per day or greater, and for depths of 2,000 feet or more. When the depth of the wells are under 2,000 feet and the production is not in excess of 2,000 bbls. of 3,000 bbls. per day, or in deep wells where the discharge is under 1,000 bbls. per day, the arrangement shown in Figure No. 5 has been found to operate satisfactorily.

General Method of Operation

The general procedure that would appear to win the greatest quantity of oil, and to obtain this oil at the lowest cost, would be to tube the well as soon as it is brought in with the design that will result in the maximum efficiency; this design will depend upon the quantity of oil that is produced, on the pressure and quantity of the gas accompanying the oil, and on the depth of the well and diameter of the casing. In many cases compressors will not be needed as there will be sufficient gas present to operate as a natural gas lift. Conservation of the gas in this manner will continue the natural flowing condition for a longer time, and the ultimate recovery will be increased. There will be a period of declining production, as is usual in all oil wells, and as soon as the gas associated with the oil is insufficient to lift the oil to the surface, compressed gas should be admitted to make up the deficiency of gas dissolved in the oil in order to reduce to a minimum the escape of gas from oil that is not lifted. It has been shown that a change in the design of tubing from time to time as the flow diminishes will reduce the quantity of compressed gas that it is necessary to use, and will allow the air lift to operate successfully at very low production. Some wells in Seminole have been operated on gas lift at 25 bbls. per day, and where efficient designs and efficient operating methods are employed this method promises to become a profitable method of raising the oil. In Seminole, owing to crooked holes, water encroachment, etc., involving constant valve and rod troubles it is doubtful whether the use of the beam for pumping these wells producing 25 bbls. of oil per day can be made to show an operating profit.

Future Methods and Possibilities

The general method of producing oil that appears at the present time to have the greatest possibility of success in obtaining the maximum recovery at the lowest cost is that of using the gas lift for raising the oil to the surface, where the gas is separated from the oil and then delivered to the gasoline plant where the gasoline is removed from the gas. The residue gas would then be returned partly to the well for use in the gas lift, while another portion would be pumped into "key" wells for maintaining the pressure in the sand. The maintenance of a fairly high pressure in the sand would serve the following purposes:

1. There can be maintained a high differential pressure between the sand and the well, thereby providing the means of moving the oil through the sand and at the same time permitting a pressure to be maintained at the well sufficient to enable the gas lift to operate successfully and efficiently.
2. Viscosity of the oil will be held at a low point thereby enabling the oil to be moved through the sand with minimum loss of pressure.
3. Absorption of the gas in the oil will be more effective and the pore spaces will, in consequence, become more readily filled with the fluid thereby reducing the tendency toward by-passing, or channeling.
4. Encroachment of edge water will be delayed to maximum extent.

With this cycle of gas completely closed, the decline in production should ultimately approximate that of almost complete exhaustion of the sand. Whether the recovery will be 50 per cent, or 75 per cent, or greater, cannot be definitely prophesied, but there would appear to be a certainty of recovering a much greater quantity than the 15 to 25 per cent now supposed to be recovered.

CENTRAL WEST FIELDS

(Continued from Page 65)

starting a test on the Charles Shaul farm, Section 17, while to the north in the same county, Murphy and others are starting a test on the John Harrison farm, Section 21, Liberty Township, same county. In Eden Township, same county, the Great Northern Oil Co. is drilling a second test in the Frank Funk farm, Section 4.

In Danbury Township, Ottawa County, between Port Clinton and Sandusky the Ohio Oil Co. has skidded its rig at its test on the Fred Block farm, Section 4, and is drilling ahead. This test, should it prove a commercial producer, will add a large acreage to develop, not being far removed from the wells producing in Catawba Island, also in Ottawa County and just east of Port Clinton, the county seat.

In Perrysburg Township, Wood County, George L. Haubert and others are drilling a second test on the Catherine Smith farm, Section 29, and Huffman and others are drilling No. 1 on the Mary Ritzel farm, same township. Hulse & Kundts

Using a "Free" JACK SQUIB in this well

Cost $1530.00

Cost of Jack Squib
Casing Crew — $280.00
Drilling Crew — 400.00
New Casing — 50.00
Lost Oil — 800.00
total cost of Jack $1530.00
total cost of Zero Hour Bomb $85.00

During the past month a nationally known producing company had a $40,000 well ready to shoot in the Texas Panhandle. The well was 3,000 feet deep, with 1200 feet of oil standing in the hole.

This major company commonly specifies Zero Hour Electric Bombs for shooting all wells. But in this instance the superintendent, as a matter of economy, decided to take a chance with a free jack squib in order to save the cost of a bomb.

The jack was dropped. Perhaps its fall was retarded. Or the fluid pressure may have caused the fuse to burn faster. At any rate the jack exploded in the oil string, bursting the pipe.

The cost of this so-called "free" jack squib was:

Casing Crew, 4 days @ $70	$280
Drilling Crew and Tools, 4 days @ $100	400
1 Joint Oil Casing	50
200 barrels production lost for 4 days, 800 bbls. @ $1	800
Total expense of using Jack	$1530

After spending $1530 trying to save money with an out-of-date, uncertain and dangerous method of exploding the shot, a Zero Hour Electric Bomb was finally used and put off the shot at the time set.

Zero Hour Shooting Is Cheap Insurance for Expensive Wells

At a cost of but $85 for a Zero Hour Electric Bomb, any operator can insure his well against the cost of shooting accidents like the above—or worse—which are common with jack and bumper squibs.

No Zero Hour Bomb Has Ever Exploded Prematurely

Thousands of Zero Hour Bombs have been used. Not one has ever exploded before the time for which it was set to explode. Zero Hour cannot explode until the hour hand of a sturdy and accurate watch makes contact with the firing pin at the "zero hour." Nothing can be imagined which would cause the hour hand of this watch (when enclosed in its protective cast-iron covering) to reach the "zero hour" greatly ahead of the scheduled time.

Zero Hour Will Put Off the Shot

The Zero Hour Electric Bomb functions under any conditions of heat, pressure, magnetic influence or presence of cavings. Scientific precision in design and manufacture insures accurate timing, dependable operation and safe handling.

The Zero Hour Electric Bomb can be secured through all principal torpedo companies. The advice of our engineering and shooting staff is yours for the asking.

ZERO HOUR TORPEDO COMPANY

408 Cosden Building, Tulsa, Okla.

Day Phone 2-9612; Night Phones 3-1775, 3-7650, 2-6097

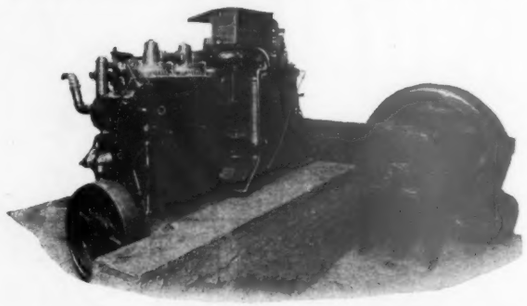
BORGER, TEXAS
Howard Culp
Phone 254, P. O. Box 411

SEMINOLE, OKLA.
Geo. Pascoe
518 Second St., Phone 410

Zero Hour
Electric Bomb

A BARGAIN!

FOR GENERATOR AND MOTOR



For sale cheap this Crocker Wheeler generator and standard open base marine motor shown above. The generator; three wire; 125 to 250 volts; 185 to 740 ampers; 50 r.p.m., size 10,900; type CCD, and 200 horse power.

Motor is 6 cylinder, 10-inch bore, 11 inch stroke, 125 h.p. at 450 r.p.m., Standard Motor Construction Co., chain driven with a single breaker switchboard.

Motor or generator can be purchased separately.

CHICAGO TRIBUNE

Tribune Tower, Chicago

If you wish to buy or sell Leases or Production, use the Classified Section

OIL LEASES and royalties, Ector, Crane, Pecos, Reeves, Ward, Upton and Winkler Counties; buy or sell. C. H. C. Anderson, 712 Linz Bldg., Dallas, Tex.

DRILLING BLOCK secured on approved acreage and well supervised; no bonus; we keep some acreage as fee. Nicolle, Petroleum Geologists and Operators. Box 1720, Fort Worth, Tex.

FOR SALE—Leases and production in Warren, Allen and Barren Counties. Have leases in Barren County joining producing leases and some within half-mile to 1 mile of production. W. P. Harley, Bowling Green, Ky.

SOUTHWEST TEXAS — WINKLER, Loving, Reeves, Ward, Pecos, Culberson Counties.
Drilling blocks. Leases. Royalties. Ranches in fee.
H. F. Anthony, Pecos, Tex.

J. F. MARION OIL COMPANY
Magnolia Building
Dallas, Texas
Buys and sells Texas Oil Leases and Royalties.

The Oil and Gas Journal Classified Ads bring buyer and seller together.

well-known Cleveland operators, are drilling a second well on the E. A. Judson farm, Section 3, Liberty Township, same county.

Central Ohio

The Central Ohio fields, like other areas of the Central West could accomplish but little in the way of operations since the last report, owing to the heavy rains and high water over the country. Only three completions were reported, one a dry hole, and two producing wells that were found in Hardy Township, Holmes County. There were 11 new locations for wells made and 6 new wells started drilling, which indicates that work will go along at a rapid clip as soon as weather conditions improve. The dry hole was drilled by J. E. Ringle and others in the southwest corner of the A. N. Robison 9 acres, Section 12, Clear Creek Township, Ashland County.

In Jefferson Township, Knox County, H. E. Perkins has started a test, 350 feet from the north line and 700 feet from the west line of the C. I. Sheldon 40 acres, Section 11.

Green, Clear Creek and Sullivan Townships, of Ashland County, are now getting an interesting wildcat play. In Green Township, the Logan Gas Co. is drilling No. 1 in the southwest corner of the Fred Sniveley 40 acres, Section 34. Ohio Fuel Gas Co. made a location for a test in the northeast corner of the E. J. Stitslein 48 acres, Section 22, also for No. 1 in the northwest corner of the J. W. Kettering 70 acres, Section 27. In Clear Creek Township, the Logan Gas Co. made a location for a test 750 feet the east line of the Andrew Paxton 104 from the north line and 660 feet from acres, Section 12, and a location for a test 606 feet from the south and east lines of the Hulda Shaw 80 acres, same section. Ohio Fuel Gas Co. staked a location for a test 660 feet from the south line and 750 feet from the west line of the Emma Lucas 104 acres, Lot 99, Sullivan Township, same county.

In Medina County, Lafayette Township, the Logan Gas Co. made a location for a test 450 feet from the north line and 733 feet from the east line of the I. O. Leggett 30 acres, Section 8. Same company has started the drill at a test in the southwest corner of the George and Tim Metzger 77 acres, Lot 21, Brunswick Township. The Empire Gas & Fuel Co. is drilling its test in the northwest corner of the J. N. Ganyard 100 acres, Lot 35, Granger Township, same county.

The Ohio Fuel Gas Co. staked a location for a test in the northwest corner of the Louise A Krenger 79 acres, Lot 15, Columbia Township, Lorain County.

Glen Harmon and others are starting a test in the southeast corner of the R. C. McFadden 16 acres, Section 8, Chester Township, Wayne County.

The only new development started in Hardy Township, Holmes County, was the making of a location by the East Ohio Gas Co. on the Stephen R. Williams farm, Lot 11. In Richland Township, same county, I. E. O'Neil is starting a test in the northeast corner of the James Dete 183 acres, Section 2. The Ohio Fuel Gas Co. is drilling a test in the southeast corner of the J. H. McFarland 140 acres, Section 16, same township.

In Coshocton County, Monroe Township, the Ohio Fuel Gas Co. has made a location for a test 330 feet from the north line and 660 feet from the Samuel Miller 20 acres, Lot 2.

Hulse and Kundtz are starting a second test in the northwest corner of the G. H. Barnum 18 acres, Lot 31, Olmstead Township, Cuyahoga County.

GAS IN LOUISIANA AND IN NORTHERN ARKANSAS

(Continued from Page 333)

from the Nacatoch sand from a depth of approximately 950 feet, and from the Blossom sand from a depth of 1,850 to 1,900 feet. A still lower horizon, of Washita age, at a depth of 2,800 feet, has been found to produce gas, but very few of the wells have penetrated it.

The average initial rock pressure from the Nacatoch sand in the Waskom Field was 410 pounds per square inch. It is, at present, 215 pounds to the square inch.

The Blossom sand, in the Waskom Field, had an initial rock pressure of 795 to 800 pounds to the square inch, with a present rock pressure of one-half that amount.

A part of the gas from the Bethany-Waskom gas fields is piped to Shreveport and a part is sent through the Magnolia gas line to the Gulf Coast towns.

The Magnolia is now laying a gas line to Dallas. A part of the gas to supply the line will come from the Bethany-Waskom Field, a part from the Pine Island Field and a part from the Cotton Valley-Sarepta areas.

Richland Gas Field

The most recent gas field to be developed in this general area is the Richland Parish, Louisiana, Field, which was opened in 1926 by the Gulf Refining Co.

The area already proven extends over a distance of 11 miles long without defining its length. The width has not been defined. The area, when developed, will probably cover 50 square miles or more. The lower gas is from the lower Cretaceous formation, from a depth of around 2,430 feet or lower.

All of the gas is rich in gasoline, carrying 125 gallons or more to the million.

El Dorado Gas Fields

All of the oil fields in the region of El Dorado, Ark., have produced gas, but only in association with oil. The original discovery well in the south El Dorado Field came in as a gasser.

There were a few individual gas wells in the south El Dorado Field which supplied gas for fuel for drilling rigs and for the town of El Dorado.

The discovery well in the Smackover Field blew out and wrecked the derrick, forming a deep crater. In fact the upper part of the structure, in the Nacatoch sand, produced gas only. Then for a distance of 100 feet down the sides of the structure oil was found in the Nacatoch sand. The Nacatoch gas was largely dissipated through wild wells and in flowing oil wells.

Gas was present in the Meekin sand in the Norphlet area at a depth of 2,250 to 2,300 feet; in the Blossom sand from 2,575 to 2,625 feet; and in the "Deep Gas Sand" from 2,675 to 2,725 feet.

There was more or less gas in all of the six producing sands of the Smackover Field. The sand at a depth of 2,675 feet was principally a gas sand.

In the Urbana Field, east of El Dorado, gas comes from the Graves sand at a depth of 2,625 to 2,650 feet. Some of the recent completions are reported as 35,000,000 cubic feet, initial production.

In all of the southern Arkansas fields gas has been a secondary consideration on account of its association with oil. Gas has been used in El Dorado, Camden and intervening towns, for domestic consumption and for drilling and pumping wells.

Future of Gas

Southern Arkansas and northern Louisiana seem more than blessed with large areas of favorable gas territory.

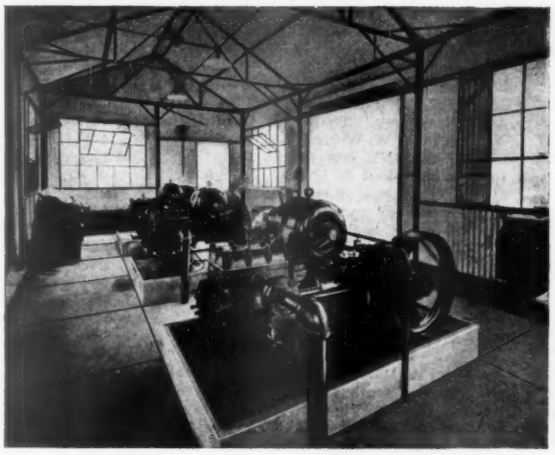
In the early development of this region, like most other gas fields, there was a criminal amount of neglect and waste permitted in the drilling and development of the gas fields. Most men and companies were looking for oil and when they found only gas, the wells were often neglected, and if a crater was formed in the drilling, the wells were abandoned and allowed to exhaust themselves.

With the passage of conservation measures by the state, and with a ready market for gas, the more recently completed gas wells are regarded as a source of profit, especially where the gasoline is extracted from the gas.

Of course all gas fields, even though they may be properly taken care of and the waste eliminated, eventually become exhausted, but with fields like Monroe with 16 years supply in sight, under the present rate of withdrawals, the future gas supply will not be a source of worry for some time to come. It is safe to assume that the gas fields of this region will last as long as the oil fields.

There are also a few excellent looking prospective gas fields in this region yet to be drilled with perhaps others that are still in hiding from man's destructive, or shall we say constructive, plans.

Motors for Pipe Line Pumping



Three 25 h.p. Wagner motors used in pipe line station near Kiefer, Oklahoma.

Wagner motors are giving excellent results under the severe requirements of pipe line pumping service. Of heavy construction, excellent design and workmanship, these motors are sold by specialists well acquainted with the requirements of the Petroleum Industry.

Products

Motors—Single and Polyphase
Fynn-Weichsel Motors
Transformers—Power and distribution
Fans—Desk, Wall and Ceiling types
Official service representatives
Lockheed four wheel hydraulic brakes.

WAGNER ELECTRIC CORPORATION
Saint Louis, U. S. A.

WAGNER OIL FIELD SPECIALISTS LOCATED AT—

Kansas City	Dallas	Los Angeles
Tulsa	Houston	San Francisco

6336-5

Neilan Casing Head Regulator

Large Capacity, Close Regulation, Simple Construction

Neilan Casing Head Regulators have valves of full pipe size area and will pass the full capacity of the inlet pipe.

The large diaphragm area and freedom from friction surfaces insure accurate and sensitive regulation.

Neilan Casing Head Regulator No. 52.

The construction of the diaphragm chamber cushions the pulsations from and the effect of heading wells. The regulator will not pound or chatter. No dashpot is necessary. Smooth, sensitive operation can be relied on.

By simply moving the weights on the lever the regulator may be set for vacuum or pressure. The weather hood keeps out dirt, rain, hail, snow, etc.
Easy to install - - - no equalizing pipe necessary.
Write for Bulletin No. 47.

NEILAN, SCHUMACHER & CO.
641-651 Santa Fe Avenue
Los Angeles, California
Branch Office: 626 Mayo Building, Tulsa, Okla.
P. H. Wilkinson, Manager

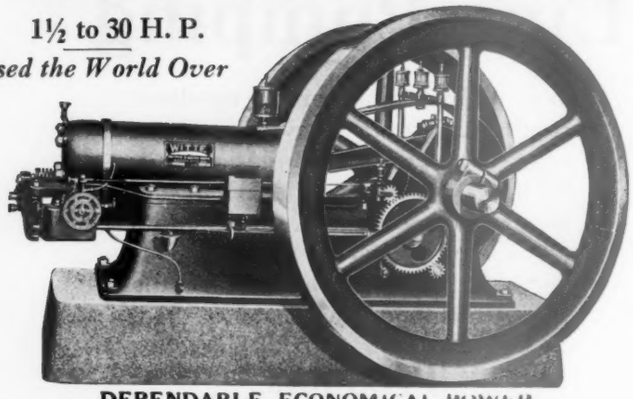
Representatives:
Maintenance Engineering Corp.
2000 Harrington Street,
Houston, Texas
Pelican Well Tool & Supply Co.
Shreveport, La.

"You Can Be Sure of Neilan Products"

WITTE ENGINES

1½ to 30 H. P.

Used the World Over



DEPENDABLE, ECONOMICAL POWER

For Oil Fields, Cotton Gins, Factories, Saw Mills, Etc.

The Witte Heavy Duty Engine is made only in the 20 and 30 H.P. sizes for heavy continuous work involving running for more than twenty-four hours at a time. Complete oiling system for every bearing so arranged that you need not shut down the oil. Geared Centrifugal Water Pump for circulating water and spraying it. Tank is in base securely supported a slight distance from the foundation. You will find this a real dependable and economical engine. Now, more than ever, the need for economical, dependable power, is felt by the producer who is faced with ever increasing labor costs. Witte Throttling Governor Engines answer this problem—with the Witte you get more engine power for less cost and less upkeep.

Throttling Governor—the original and leader of the Throttling Governor type. An even, steady speed with big surplus of power for heavy loads. The Witte Engine burns kerosene, gasoline, gas oil, distillate or gas, at a fuel cost of less than 2c an hour per H.P. Simple, trouble proof, and guaranteed for a life-time of hard work.

. Write for Free Book. Send today for my big, free catalog in colors. Tells all about the new Witte improvements and new sales terms. It's really a mechanical education to read this book, for I have written it after a life-time of practical experience. Write for it today, sure.

The Witte Engine comes completely equipped with Wico-Magneto speed and power regulator and Throttling Governor, square, protected tank and cast removable bearings. The Witte is regarded the world over as the STANDARD for real economy and life-long dependability.

No matter whether you plan to get an engine now or later—no matter whether you happen to have my old catalog—write me today, sure, for this big, new catalog and learn about all my new improvements and new terms. Do not think of buying any engine, sawing rig, or pumping outfit until you have got all these facts. Write today for free facts. No cost or obligation.

3 Hours Shipping Service

WITTE ENGINE WORKS, Dept. W

302-A Witte Bldg., Kansas City, Mo.

302-A Empire Bldg., Pittsburgh, Pa.

Petrol Belt / Petrol Belt Clamp / Petrol Rotary Belt Punch for BEST OIL FIELD BELT SERVICE

In the Mid-Continent Fields at all branches and stores of WILLIAMSPORT WIRE ROPE CO.

In California at CHRISTIE-FREY COMPANY Los Angeles, Cal.

In the Eastern Fields at JARECKI MFG. CO.

"Petrol Belting & Petrol Clamps Make the Ideal Combination"

Manufacturers

Victor Balata and Textile Belting Co.

Main Sales Office: 38 Murray St., New York City

Factories: Easton, Pa.

NEW LOCATIONS IN TEXAS PANHANDLE AND NORTH AND WEST TEXAS FIELDS

TEXAS PANHANDLE

Gray County

Gibson Oil Corp's No. 1 J. B. Bowers 330 feet north and west of SE cor. of north 120 acres of the E half of Section 92, Block 2-B, H. & G. N. Survey. Magnolia Petroleum Co.'s No. 1 W. C. Archer, 330 feet south and east of NW cor. of N half of SE of Section 174, Block 3, I. & G. N. Survey. The Texas Company's No. 1 Combs & Worley, 330 feet south and west of NE cor. of the E half of Section 58, Block 3, I. & G. N. Survey. H. F. Wilcox and others' No. 1 Combs & Worley, 330 feet north and 1,050 feet east of SW cor. of Section 40, Block 3, I. & G. N. Survey and located on their 30-acre lease; No. 2, 330 feet north and east of SW cor. of Section 40, Block 3, I. & G. N. Survey; No. 3, 945 feet north and 330 feet east of SW cor. of Section 40, Block 3, I. & G. N. Survey.

Hutchinson County

Gwynn & McKnight's No. 3 E. Cockrell, 990 feet south and 330 feet west of NE cor. of the W half of NE of Section 1, Block Y. McMan Oil & Gas Co.'s No. 1 Albert Yake, 330 feet north and east of SW cor. SE of Section 2, Block J, H. & G. N. Survey. Navajo Oil Co.'s No. 1 E. Cockrell-Dickson, 220 feet south and 330 feet east of NW cor. of N half of SE of Section 3, Block 3-B, D. & S. E. Survey.

NORTH CENTRAL AND WEST TEXAS

Archer County

Ray & Massie's No. 1 L. F. Wilson-A, 150 feet south and west of NE cor. NE SE of Section 1, S. P. R. R. Survey, A-412. Roxal Petroleum Co.'s No. 7 L. F. Wilson, 460 feet south and 450 feet east of NE cor. of Section 1, S. P. R. R. Survey, A-412, and located in D. L. & C. Survey, A-1,093, being 450 feet north and east of SW cor. of their 40-acre lease. Simms Oil Co. and Consolidated Oil Co.'s No. 4 J. M. Turbeville, 150 feet south and west of NE cor. of their 47-acre lease out of Robert Carson Survey, No. 146. United Production Co.'s No. 1 J. J. Perkins and others, 150 feet south and 750 feet west of NE cor. NE of Section 22, League 3, Denton County School Land, A-117. Sun Oil Co.'s No. 1 R. O. Andrews, 1,000 feet north and 150 feet east of SW. cor. of north 185 acres of R. O. Andrews' 355-acre tract out of R. R. Rainey Survey, A-354.

Brown County

Curry & Moore's No. 6 G. W. Pickett, 465 feet north and 150 feet east of SW cor. of G. W. Pickett's 150-acre tract out of Greenberry Logan Survey, No. 147. Gibson Oil Corp.'s No. 9 J. W. Shire, 1,350 feet south and 150 feet east of NW cor. of east 80 acres of north 160 acres of J. C. Ryan Survey, No. 635; No. 12, 150 feet south and 750 feet east of NW cor. of east 80 acres of north 160 acres of the same survey. J. K. Hughes' No. 15 J. W. Shore, 1,050 feet south and 150 feet west of NE cor. of west 80 acres of north 160 acres of the same survey; No. 16, 1,350 feet south and 150 feet west of NE cor. of west 80 acres of north 160 acres of the same survey; No. 20, 150 feet north and 1,050 feet east of SW cor. of west 80 acres of north 160 acres of the same survey; No. 21, 150 feet north and 750 feet east of SW cor. of west 80 acres of north 160 acres of the same survey; No. 31, 410 feet north and 900 feet east of SW cor. of west 80 acres of north 160 acres of the same survey; No. 32, 410 feet north and 500 feet east of SW cor. of west 80 acres of north 160 acres of the same survey; No. 35, 900 feet south and 710 feet east of NW cor. of the same survey. Lont Brothers' No. 1 Mrs. A. Armstrong, 150 feet north and west of SE cor. of east 100 acres of west 260 acres of Mrs. A. Armstrong's 640-acre tract out of H. & G. N. Survey. No. 1 A-1,217. C. O. Moore's No. 1 E. G. Wright, 150 feet south and west of NE cor. of E. G. Wright's 100-acre tract out of S. A. & M. G. Survey, No. 3, A-850. Phillips Petroleum Co.'s No. 6 Roy Hickman, 150 feet north and 200 feet east of SW cor. of their lease out of Thomas Benson Survey, No. 783. Root and others' No. 1 E. C. Robertson, 150 feet south and 200 feet east of the most westerly NW cor. of E. C. Robertson's 300-acre tract out of S. A. & M. G. Survey, No. 3, A-850. E. M. Schaffer's No. 4 E. D. Henson, 750 feet south and 150 feet east of NW cor. of their lease out of E. D. Henson tract and located in J. H. Panther Survey, A-075. Sinclair Oil & Gas Co.'s No. 5 J. W. Shore, 150 feet south and 750 feet east of NW cor. of their 80-acre lease out of J. C. Ryan Survey No. 635; No. 6, 450 feet south and 150 feet east of NW cor. of the same 80-acre lease; No. 7, 150 feet south and 1,050 feet east of NW cor. of the same 80-acre lease. The Texas Company's No. 2 John Byler, 450 feet north and 150 feet east of SW cor. of J. Byler's 44-acre tract out of T. & N. O. Survey, No. 43; No. 83 Mrs. R. M. Lowe, 150 feet north and 3,110 feet east of SW cor. of George Stubblefield Survey, No. 622.

Clay County

M. T. McClure and others' No. 1 John Barry Jr., 150 feet south and west of NE cor. of south 30 acres of Lot 14, Section 2,642, T. E. & L. Survey. E. J. Stump & Co.'s No. 1 H. Bobby, 470 feet SE of NW line and 150 feet SW of NE line of Section 47, Bacons Subdivision; No. 2, 660 feet SE of NW line and 450 feet SW of NE line of the same section.

Coleman County

Henshaw & Grasey's No. 1 J. W. Gates, 150 feet north and west of SE cor. of J. W. Gates' 100-acre tract out of E. T. R. R. Survey, No. 279. McIntyre and others' No. 1 S. W. Mullanax, 150 feet north and west of SE cor. of SW of Section 5, T. & N. O. Survey. W. A. Hutson's No. 1 C. L. Curry, 485 feet south and 750 feet west of NE cor. of C. L. Curry's 215-acre tract out of H. Rhodes Survey, No. 631.

Comanche County

J. M. Hickey's No. 1 J. M. Mauncey, 750 feet north and 450 feet east of NW cor. of west 40 acres of SE of Section 50, Block 2, H. & T. C. Survey.

Cooke County

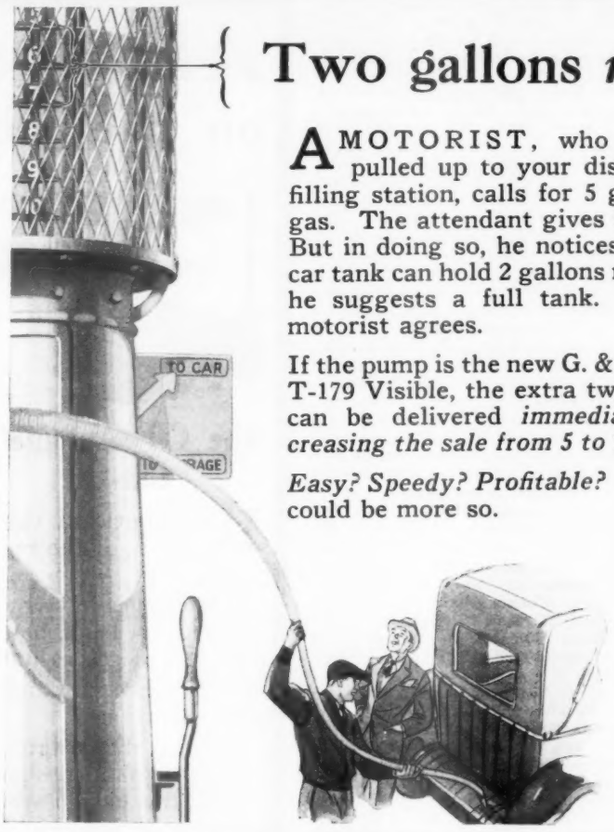
Kewanee Oil & Gas Co.'s No. 2 H. L. Dennis-A, 450 feet south and 150 feet west of NE cor. of H. L. Dennis' 40-acre tract out of the S half of T. J. Hutchinson Survey, A-484. Oil Operators Trust Co.'s No. 5 Ben Luke, 150 feet north and 565 feet west of SE cor. of Block 89, Town of Muenster. Vacuum Oil Co.'s No. 1 Mrs. M. Beckleman, 1,030 feet south and 300 feet west of NE cor. of Section 17, Fannin County School Land, A-1,248.

Crane County

Magnolia Petroleum Co.'s No. 10 University-O'Keefe, 990 feet south and 1,650 feet east of NW cor. of Section 38, Block 30, University Land. Magnolia Petroleum Co. and Hardwick's No. 9 University Land, 990 feet south and 1,650 feet west of NE cor. of Section 46, Block 30, University Land. Prairie Oil & Gas Co.'s No. 2 State-Lasseter, 990 feet south and 2,310 feet west of NE cor. of Section 47, Block 30, same land. Simms Oil Co. and Atlantic Oil Production Co.'s No. 6 University Land-C, 990 feet south and 2,310 feet east of NW cor. of Section 47, Block 30, same land.

Eastland County

Belva Oil Co.'s No. 1 C. T. Homer, 225 feet south and 1,200 feet east of NW cor of C. F. Homer's 200-acre tract out of W. Willis Survey, No. 2. Louisiana Oil & Refining Co.'s No. 1 W. M. Sneed, 245 feet south and 150 feet east of NW cor. of north 71 acres of south 145 acres of Section 22, McLennon County School Land, No. 2. The Texas Company's No. 14 L. A. Hightower, 380 feet north and 150 feet west of SE cor. of their 100-acre lease out of Section 1, William Van Norman Survey. Brannon & Murray's No. 2 Bennett-Botch, 150 feet north and



Two gallons *more* you can sell him

A MOTORIST, who has just pulled up to your distributor's filling station, calls for 5 gallons of gas. The attendant gives it to him. But in doing so, he notices that the car tank can hold 2 gallons more. So he suggests a full tank. And the motorist agrees.

If the pump is the new G. & B. Model T-179 Visible, the extra two gallons can be delivered *immediately, increasing the sale from 5 to 7 gallons.*

Easy? Speedy? Profitable? Nothing could be more so.

Starting delivery always with a full 10 gallons in the bowl, this new G. & B. T-179 Visible enables your* distributors to boost gallonage. To sell those extra two, or more gallons without taking the time and trouble of refilling the bowl.

This is the G. & B. PROGRESSIVE METHOD OF DELIVERY. You find it in the new Model T-179 Visible, mechanical measure type. Also in the Model T-176 Visible wet hose sight measure type.

Write for Bulletins.

GILBERT AND BARKER MANUFACTURING COMPANY
PUMPS AND TANKS FOR THE OIL TRADE
SPRINGFIELD MASS. U.S.A.

*Over 1200 oil marketers are using G. & B. equipment.

PUMPS THAT HELP YOU SELL

One *long-service* tank* is worth two that will not withstand depreciation!

Specify Sheffield Copper Steel Sheets

SHEFFIELD STEEL CORPORATION
KANSAS CITY, MO.

New Billet Reinforcing Bars . . Rail Steel Reinforcing Bars . . Blue Annealed Sheets . . Merchant Steel Bars
Merchant Iron Bars . . Bolt and Nut Products . . Sucker Rods . . Pull Rods . . Track Spikes . . Forgings

Only 8 pounds of chasers to buy instead of 144 pounds of dies

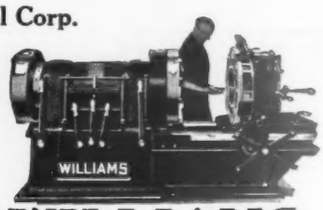
That's the comparison between a 12-inch RAPIDUCTION and an ordinary pipe threading machine in the 12-inch size.

And this tool steel that you save is only one of the economies of the RAPIDUCTION.

Other costs are far lower; there's less time spent in recutting; you don't have to put in a whole new set if you snip one die. In a few seconds you put in a new chaser, at slight expense.

Get the facts complete— this gives you only an outline of the TIME-SAVING and COST-CUTTING of RAPIDUCTION threading.

Williams Tool Corp. **Erie, Pa.**



WILLIAMS
RAPIDUCTION
POWER PIPE MACHINE
HARRON, RICKARD & McCONE CO.
San Francisco California Los Angeles

Gott Water Can or Gottkool

Built to last—you will always be assured of a fresh supply of pure water, when you have a GOTT. Made in 1½, 3, 5 and 10 gallon sizes. Order now from your supply store.

H. P. GOTT MFG. CO.
Winfield, Kansas

CARBON (BLACK DIAMONDS) FOR DIAMOND CORE DRILLS

—IMPORTERS—
INDUSTRIAL DIAMONDS
—MANUFACTURERS—
DIAMOND POINTED TOOLS FOR ALL MECHANICAL PURPOSES

WRITE OR WIRE FOR CATALOGUE AND FULL PARTICULARS
THE DIAMOND DRILL CARBON CO.
61 PARK ROW, NEW YORK, N.Y. CABLE ADDRESS, CREDOTAN, N.Y.

west of SE cor. of north 15 acres of east 25 acres of west 65 acres of the N half of Section 99, Comal County School Land. Brown & Co. Inc.'s No. 3 S. B. Edwards, 150 feet south and 480 feet west of NE cor. of south 105 acres of Section 99, same school land. Shadbolt & Creighton's No. 1 R. C. Wylie, 150 feet south and east of NW cor. of the S half of SE of Section 57, Lunatic Asylum Land. Valley Oil Co.'s No. 2 H. H. Ramsey, 150 feet north and east of SW cor. of NE Section 31, Deaf and Dumb Asylum Land; No. 3, 150 feet north and 750 feet east of SW cor. NE of Section 31, same asylum land. White Eagle Oil & Refining Co.'s No. 1 J. O. Hall, 660 feet north and 3,300 east of SW cor. of Section 1, T. & P. Survey.

Glasscock County

Landreth Production Co.'s No. 1 A. L. Houston, 330 feet south and west of NE cor. NW of Section 12, Block 35, Tp-2-S, T. & P. Survey.

Grayson County

Sowell Brothers' No. 1 G. W. Cannon, 285 feet south and 400 feet east of NW cor. of A. Martin' Survey, A-832, and on G. W. Cannon's 40-acre tract.

Howard County

Comet Petroleum Co.'s No. 2 H. R. Clay, 220 feet south and 815 feet east of NW cor. of Section 154, Block 29, W. & N. W. Survey.

Jack County

Shaw & Rathke's No. 1 J. W. Cullers and others, 250 feet south and west of NE cor. SE of Section 4, S. P. R. R. Survey, A-1,288.

Montague County

Continental Oil Co.'s No. 2 J. E. Crowe and others, 150 feet south and west of NE cor. of north 20 acres of J. E. Crowe and others' 100-acre tract out of J. Chambliss Survey ,A-123. E. W. Skinner and others' No. 2 J. W. Maddox, 450 feet south and 150 feet west of the most northerly NW cor. of J. W. Maddox's 335-acre tract out of the same survey. Sinclair Oil & Gas Co. and others' No. 1 W. W. Brown, 660 feet NE of SE line and 895 feet NE of SW line of G. W. Brown's 125-acre tract out of L. E. Totty Survey.

Pecos County

Marland Oil Co.'s No. 1 I. G. Yates, 660 feet south and 7,015 feet west of NE cor. of west 755 acres of Section 34½, Block 194, G. C. & S. F. Survey. Mazda Oil & Gas Corp.'s No. 1 M. A. Smith, 250 feet north and west of SE cor. of NW of Section 24, Block 194, same survey. Mid-Kansas Oil & Gas Co.'s No. 5 I. G. Yates, 1,320 feet north and 250 feet east of middle SE cor. of Section 33, Block 194, G. C. & S. F. Survey and located in I. G. Yates Survey, A-8,195, being 500 feet due east of the Mid-Kansas' No. 1 Smith & Taylor; No. 6, 250 feet south and 785 feet east of SW cor. of Section 60, Block 1, I. & G. N. Survey and located in the same survey.

Shackelford County

Albany Oil Co.'s No. 5 W. D. Reynolds, 2,010 feet south and 810 feet east of NW cor. NE of Section 24, Block 11, T. & P. Survey. Gibson & Murphy's No. 2 J. B. Matthews, 150 feet north and 450 feet west of SE cor. NW of NE of Section 58, Block 10, E. T. R. R. Survey. H. Gwinnup and others' No. 1 W. H. Green, 660 feet south and east of NW cor. SW NE of Section 65, Block 12, T. & P. Survey. Humble Oil & Refining Co.'s No. 2 G. R. Davis, 1,500 feet south and west of NE cor .of Section 10, Block 13, T. & P. Survey. McGinley and others' No. 1 W. D. Reynolds, 660 feet south and east of NW cor. NW NW of Section 25, Block 11, T. & P. Survey.

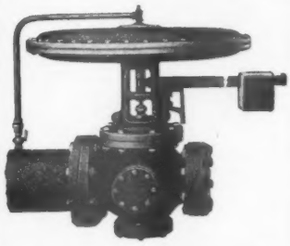
Stephens County

Red Bank Oil Co.'s No. 1 J. J. Robertson, 1,410 feet west of SE cor. of P. Norton Survey. Texas Consolidated Oil Co.'s No. 10 O. S. Martin, 1,480 feet south and 1,465 feet east of NW cor. of Section 1,041, T. E. & L. Texas Pacific Coal & Oil Co.'s No. 71 Charles Binney. 1,310 feet south and 1,525 feet west of NE cor. of Section 53, Block 4, T. & P. Survey.

Wilbarger County

Consolidated Oil Co. and J. S. Cosden's No. 5 W. J. Waggoner, 600 feet south and 450 feet west of NE cor. NE NW of Sec-

Always on the job!



The C-F Automatic Cut-Off

It automatically closes the ports of the regulator valve.

The valves have to be opened by hand before the flow of gas resumes.

No chance for dangerous explosions.

If the diaphragm of the regulator should burst, this cut-off would stop the flow of gas immediately.

More than thirty years of experience in controlling gas pressure has taught us how to make this device dependable in its operation.

The Chaplin-Fulton Mfg. Co.

Organized 1884—oldest builders of gas regulators in the country. Built in all sizes, from 1 inch to 24 inches; for all services, 1 oz. up to 1,600 lbs. pressure to square inch.

28-34 Penn Avenue
Pittsburgh, Pa.

271

PRIMM OIL ENGINES

FOR DRILLING
PUMPING AND
PIPE LINE WORK

Hundreds are now used in the oil fields. Their satisfactory operation for years is the best recommendation to you.

—WRITE—

THE POWER MFG. CO.
722 Cheney Ave.,
MARION, OHIO

"Oil Engine Builders for a Quarter Century"

J. Edward Jones

342 Madison Avenue

New York City

FOR SEVERAL YEARS
a
Constant Purchaser
of
OIL PRODUCING
ROYALTIES
in
Oklahoma and Kansas

Banking Connections
and
Field Representatives
throughout the
Mid-Continent
Affording Prompt Action

Chart
of
51 Oil Companies

Graph
showing the
Petroleum and Gasoline Industry
From 1919 to April 1927

Chart and Graph together with Circular mailed upon request

Ward, Gruver & Co.
Members New York Stock Exchange
20 Broad St. 131 E. 86th St.
New York

Amarillo's
Two Great Hotels

Amarillo Hotel
400 rooms—300 baths
Rates, $2.00 to $3.50

Herring Hotel
600 rooms—
600 baths
Rates, $2.50 to $5

Ernest Thompson Hotels—Built on good food!
Antro Hotel, Clarendon, Tex.
Panhandle Inn, Panhandle, Tex.
Memphis Hotel, Memphis, Tex.
Wilbarger Hotel, Vernon, Tex.

Original Eotvos Torsion Balances
Sold or Rented
GEORGE STEINER
330 Houston Post-Dispatch Building,
HOUSTON, TEXAS

tion 57, Block 4, H. & T. C. Survey. Waggoner Refining Co.'s No. 1 W. T. Waggoner-C, 150 feet south and west of NE cor. SW NW of Section 44, Block 4, H. & T. C. Survey.

Stonewall County

J. P. Johnston's No. 1. R. P. Morrow, C NE of Section 105, Block D, H. & T. C. Survey.

Wichita County

Jess Williams and others' No. 1 B. F. Dutton, 450 feet south and east of NW cor. of NE. Section 17, League 4, Denton County School Land, A-417. Consolidated Oil Co. and Apple & Brandeberry's No. 3 G. B. Ancell, 750 feet south and 150 feet east of NW cor. of SE SW of Section 11, Block 7, H. & T. O. Survey; No. 4, 450 feet south and east of NW cor. SE SW of Section 11, Block 7, same survey. T. F. Hunter's No. 1 J. L. & T. J. Waggoner-B, 150 feet south and 1,800 feet east of NW cor. of M. A. Willis Survey, A-547. Petroleum Producers Co.'s No. 2 S. I. & H. M. Munger, 150 feet south and 880 feet east of NW cor. of Section 31, Kemp's Wichita Valley Lands. The Texas Co. and others' No. 3, J. L. & T. J. Waggoner, 150 feet north and east of SW cor. of Lot 28, Hezikiah George Survey, A-454.

Corrected Locations

Hutchinson County: Anderson & Pritchard's No. 1 Albert Yake, 330 feet north and west of SE cor. NE of Section 2, Block J. H. & G. N. Survey. McMan Oil & Gas Co.'s No. 3 E. Cockrell-Martin, 220 feet south and 330 feet west of NE cor. of the S half of NW, Section 3, Block 3-B, D. & S. E. Survey. Phillips Petroleum Co.'s No. 3 W. S. Christian, 1,105 feet north and 240 feet west of the most southerly SE cor. of W. S. Christian Survey, No. 7, Block V, A-1,237.

In Archer County: L. Wilson & Russell's No. 7 H. O. Prideaux, 150 feet south and 2,085 feet east of NW cor. of H. O. Prideaux's 345-acre tract out of A. Rohus Survey, A-1,126.

In Callahan County: Brannon & Murray's No. 1 Bennett-Booth, 150 feet south and west of NE cor. of east 25 acres of west 65 acres of the N half of Section 99, Comal County School Land. Valley Oil Co.'s No. 1 H. H. Ramsey, 150 feet south and east of NW cor. SE of Section 31, Deaf & Dumb Asylum Land.

In Eastland County: C. C. Dodson and R. P. Rankin's No. 1 M. E. Cade, 1,470 feet south and 4,110 feet west of NE cor. of M. E. Cade's 738-acre tract out of J. Roberts Survey.

In Reeves County—Deep Rock Oil Co.'s No. 1 Caldwell, C SW of Section 22, Block 58, Tp-7, T. & P. Survey.

Brewster County

McPhail & Kempner's No. 2 McIntyre, 300 feet from south and west corner of Section 3, Block 352.

Crane County

Magnolia Petroleum Co.'s No. 4 State-Lasseter, 2,310 feet from south and 330 feet from east line Section 34, Block 30. Humble Oil & Refining Co.'s No. 11 University, 1,650 feet from west and 990 feet from south line, Section 38, Block 30.

Glasscock County

California Co.'s No. 1 W. B. Currie, 2,970 feet from south and 990 feet from west line Section 215, Block 29, W. & N. W. Survey. Sid Richardson and associates' No. 1 Berge Forbes Land Co., 150 feet north and east of SW cor., Section 183, Block 29.

Midland County

Orbit Oil Co.'s No. 1 Moreland, C SE, Section 17, Block 39, T. & P. Survey.

Pecos County

Red Bank Oil Co.'s No. 1 McKenzie, CN half, Section 21, Block 126, T. & S. L. R. R. Survey. Simms Oil Co.'s No. 1 A. J. Dowlin, C NE, Section 12, Block 105, G. C. & S. F. Survey, Moutray Oil Co.'s No. 1 A. G. Robertson, 1,600 feet from NE and 2,310 feet from SE line of Section 28, Block 10, H. & G. N. Survey. (Taken over from Pecos Big Three.) Mid-Kansas Oil & Gas Co. and Transcontinental Oil Co.'s No. 7-A Yates, 200 feet west and 250 feet north of SW cor., Section 61, I. N. G. Survey, but in Section 34½.

Taylor County

Gilbert Johnson's No. 1 C. M. Brown, 660 feet from south and west line of

McGregor Working Barrel

McGREGOR

"The Working Barrel That Works"

Over sixty thousand now in use from Pennsylvania to Argentine and from Oklahoma to India wherever oil is produced.

No Barrel can compete with the McGregor in price and saving. It comes with the barrels, valves, valve stem all complete at a price slightly more than what the old style Barrel would cost. Pumps as fast as old style barrels that are attached to the tubing.

The only pulling done when you have a McGregor in use is the rods as the complete Barrel is fastened to the rods and comes out when they are pulled. TUBING PULLING is done away with as far as the Working Barrel is concerned. Made for all size tubing. Use "Mac" Ball and Seat.

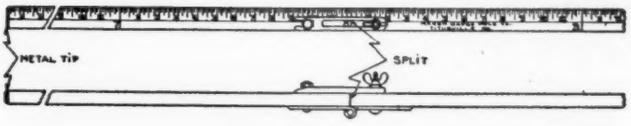
See your dealer or write us for circular

In ordering parts refer to these letters

McGREGOR WORKING BARREL CO., Inc.
Sole Manufacturers
BRADFORD, PENNA.

GAUGE POLES

Any Length **For Oil Measurements**



"MARSH-JOINT"

For sale by oil country supply houses or furnished promptly by the factory at Titusville, Pa.

Correspondence Solicited

MARSH GAUGE POLE COMPANY
TITUSVILLE, PA.

Ajax Bull Ropes

Mid-Continent Sales Distributors:
Bisett & Brown
1007 Jones Street
Fort Worth, Texas

Warehouse Representative:
H. D. Hedrick
Tulsa Transfer & Storage Co.
Tulsa, Okla.

Ajax ropes are carried in stock by the North Texas Supply Co., Cross Plains, Tex.; Rex Supply Co., Sour Lake, Tex., and Mid-Continent Supply Co., Fort Worth, Tex.

HARRY A. CAMPBELL F. LEE STEWART

NATIONAL PETROLEUM ENGINEERING COMPANY
ENGINEERS AND GEOLOGISTS
ATLAS LIFE BUILDING
TULSA, OKLAHOMA

APPRAISALS
REPORTS, COMMERCIAL AND TAX
SURVEYS
ESTIMATES OF OIL RESERVES

RYERSON

IMMEDIATE SHIPMENT FROM STOCK

Bars, Plates, Rivets, Tool Steel, Shapes, Sheets, Bolts, Welding Rods, Structurals, Tubes, Wire, Concrete Reinforcing, Rails, Pipe, Turnbuckles, Alloy Steel, Ascoloy, Small Tool, Machine Tools, etc.

Write for the Ryerson Journal and Stock List.

JOSEPH T. RYERSON & SON INC.

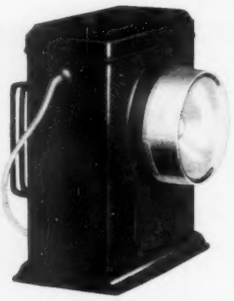
Chicago Milwaukee St. Louis Cincinnati Cleveland
Detroit Buffalo New York Boston

Tulsa Office: 410 Atlas Life Bldg.

STEEL

Houston Office: D. S. Mair 220 Main Street

Super-Illumination, Safe, and Low-Priced



ELECTRIC LANTERN
No. 10, $2.75 *list*

THE FINEST light ever developed for workers in oil fields. Insures safety against fire and explosions. It is a powerful lantern, projecting a 300-foot flood of brilliant light. Burns by the hour on two No. 6 dry cells. Batteries last up to a year in ordinary usage.

Light but rugged—will last a lifetime. Made of sheet steel for tough wear and ribbed for extra strength. Finished in vivid red baked enamel. Durable. Attractive.

Scientifically designed for super illumination. Triple silver plated reflector, especially designed Mazda bulb, lens ground from select clear glass—all these elements precisely adjusted according to Delta standards for powerful light.

See your dealer—or write us.

DELTA ELECTRIC CO. 608 Delta Blk. MARION, Ind.

Preferred Opinions

The Oil and Gas Journal—with its bright yellow cover—on your desk or in your home indicates that your opinions regarding the Oil Business are to be given preference.

Be among the best informed oil men. Always renew your subscription promptly.

The OIL and GAS JOURNAL
Tulsa, Okla.

Integrity

A mark of integrity and so recognized by competitors and boiler users alike. Also, definite assurance to you that all features demanded in

Modern Oil Country BOILERS

will be present in any Brownell we might recommend for your particular needs.

Brownells comply with ASME code. Brownell consulting engineers in all principal cities. Write for Bulletin B-7.

THE BROWNELL COMPANY
Dayton, Ohio

Domestic Distributors: Dunigan Tool & Supply Co., Inc., Breckenridge, Tex.

Export Division: Oil Field Machinery Co., 90 West St., New York, N. Y.

BROWNELL BOILERS

Section 1, Block 6, T. & P. Survey.

Tom Green County

H. D. Camp and associates' No. 1 Wilkey, 200 feet from north and 310 feet from west line of Section 4, Blind Asylum Lands.

Upton County

Marland Oil Co. and Levi Smith's No. 1 University, 2,640 feet from north line and 1,320 feet from east line, Section 17, Block 5, University land. Tidal Oil Co.'s No. 1 Burleson, 330 feet south and west NW cor. of The Texas Co.'s J. M. Perry lease in Section 3, G. C. & S. F. Survey and location in Section 2 of John Nidever Survey.

"RIDE AND TIE" TRAVEL BEFORE GASOLINE CAR

Modern Americans, accustomed to high speed activity, to quick and efficient communication and transportation, by the gasoline car, generally fail, says the Wall Street Journal, to appreciate the difficulties which their predecessors a few generations ago had to contend with in getting about, or even to be familiar with some of the methods of transportation utilized during the "horse age." One common practice, for example, was known as the "ride and tie" method. An Ohio historian reveals how Salmon P. Chase, Lincoln's Secretary of the Treasury and founder of the Chase Bank, made use of his scheme in traveling from his New Hampshire home to Worthington, Ohio, to live with his uncle.

Finding he would have to wait several days for a coach, he and a friend who had a horse, started on together, one riding for several miles and of course outstripping the other on foot. Then the rider would dismount, tie the horse to the fence, and proceed on foot while the friend came up behind, mounted the horse and rode a while. Thus the horse was spared a double burden and the travelers made good speed.

OIL REDUCES WEAR ON RAILROAD CURVES

Among the economies which the railroads are attempting, one of the most interesting has been that of the Norfolk & Western Railroad to protect the flange-wearing surfaces of rails with oil. This has resulted in an increase of about 400 per cent in the life of rails on its lines. The flange-wearing surfaces of rails are those on curves in the lines, and conditions in Norfolk & Western territory were so severe that the average life of a 130-pound rail on the high sides of 10 to 12-degree curves was only two or three years, while on the low sides the life was 50 per cent longer.

The railroad began experimenting two years ago, says Railway Age, with the application of oil to the inside of the heads of rails on the high sides of curves. Section men applied the oil to the rails with short paint brushes at intervals of about 12 inches, over a distance of 10 to 12-rail lengths on two curves in opposite directions. Care was taken that the oil did not touch the tops of the rail heads where it would interfere with traction. It was found that this oil was picked up by both the right and left wheel flanges of passing trains and was distributed by them wherever the flanges touched the rails for distances ranging from 3 to 12 miles. One application of oil, therefore, was found sufficient to oil adequately the flange-wearing surfaces for several succeeding curves, and the first tests were so successful that the practice of rail-oiling was spread to all other sections of the Norfolk & Western.

After a time it became evident that the slow and costly method of applying the oil by hand would have to be superseded by mechanical means. Section men assigned to the rail-oiling task devised several contrivances which were pushed by hand so as to oil the rails as fast as the worker would walk. One of the most successful of these was a simple metal container, mounted on a low carriage with double-flanged rollers, which could be pushed along the rails by means of handles. After the oiling mixture was heated it flowed through a short pipe, equipped

The Tret-o-lite Process is Economical

Recovery cost only a few cents a barrel. Practically no power expense—no payment of royalty—minimum labor. Our nearest field representative is at your service.

Wm. S. Barnickel & Co.
ST. LOUIS, MO.

RECEIVERS SALE

Complete refinery Iowa Park, Texas.

377 shares stock of Wichita Pipe Line Company, Wichita Falls, Texas.

Sale Wichita County Courthouse Monday, June 20th, at 2 p.m. Each bidder required to deposit $7500.00 certified check.

For further details communicate with

Receivers Interstate Gasoline Company
1014 Staley Building,
Wichita Falls, Texas.

Armstrong Bros. Pipe Dies and Stocks

IMPROVED DESIGN

CUT LIKE LATHE TOOLS

Backed off Chasers made of Alloy Tool Steel

Write for free catalog

ARMSTRONG BROS. TOOL CO.
No. Francisco Ave., Chicago, U.S.A.

ARTHUR C. BROWN
SOLICITOR OF UNITED STATES AND FOREIGN PATENTS
406-412 KENNEDY BLDG.,
Tulsa, Okla.
Mr. Fred Krueger
in Charge
Phone 4-2319

TURK & MAULDIN
ATTORNEYS AT LAW
209-214 Ritz Building
(Tom F. Carey, Income Tax Counsel)
TULSA, OKLA.

Cables: Cealiach, New York Telephone: Whitehall 8364
JOHN EOGHAN KELLY
Consulting Engineer
17 Battery Place, New York City, N.Y.
Passaje Colonna 6, Guatemala, C. A.
Examination, appraisal, management, negotiation of petroleum properties, mines, natural resources. Exceptional facilities in Latin America.

EDWIN B. HOPKINS
CONSULTING GEOLOGIST
25 Broadway
NEW YORK

PHILLIP MAVERICK
PETROLEUM GEOLOGIST
Telephone 93
Ricker & Dodson Bldg.
SAN ANGELO, TEXAS

Chester W. Washburne
Geologist and Engineer
27 William St., N. Y.

PATENTS *Write for Free Book*
MUNN & CO.
Associated for 81 years with the Scientific American
1551 Scientific American Building
24 West 40th Street, *New York City*
514 Scientific American Bldg., *Washington, D.C.*
1303 Tower Building, *Chicago, Ill.*
656 Hobart Building, *San Francisco, Cal.*
511 Van Nuys Building, *Los Angeles, Cal.*

TEXAS OIL MAPS
County and District
Catalog on Application
HEYDRICK MAPPING COMPANY
Wichita Falls, Texas

with a suitable regulating valve, to the top of a brush which distributed it along the gauge side of the rail heads.

The labor cost was still too high, and a machine which operates to distribute the oil as the wheels of a running train pass over it was perfected by the superintendent of one of the road's divisions. This device is described as a "covered metal box or trough, 10 feet 3 inches long by 5 inches wide and 4 inches high, which is bolted to the web of the rail on the gauge side."

"Within this box," the description runs, "is a series of 10 leather disks, about 5 inches in diameter, equally spaced throughout the box and mounted in a vertical position on suitable cross shafts. In operation these disks revolve under the influence of passing trains and carry oil from the reservoir, which the box itself provides, up to the gauge side of the flanges of the wheel with which they come in contact. This machine is installed at the center or quarter points of a rail, preferably about 100 feet ahead of a curve, and in all cases is accompanied by a gauge rail immediately opposite. The purpose of the guard rail is to prevent the crushing of the oiling disks between the flanges of passing wheels and the head of the high rail, and also to prevent the lateral motion of engine and car wheels, thereby retaining their flanges in the desired contact with the oiling disks."

SPECIAL OIL PRODUCTS ESCAPING DEPRESSION

Chesebrough Manufacturing Co. shares reflect the fact the company is in a specialty business and like Vacuum Oil has not been affected by oil overproduction and reduced prices. The business of Chesebrough dates back more than 50 years, being virtually as old as original Standard Oil. It was among the pioneer manufacturers of oil products, making kerosene oil and selling it under the trade mark "Luxor" oil. Robert A. Chesebrough believed it was possible through another method of refining to retain the medicinal qualities of oil and, through a heat refining process, petroleum jelly was produced. Chesebrough coined the word "Vaseline" for his trade-mark, the word meaning water oil. The term since has been accepted as meaning petroleum jelly. Approximately 20 other products are manufactured under the Vaseline trademark. Chesebrough has distributing branches in many parts of the world.

PENN MEX FUEL WINS ALAMO SUIT IN MEXICO

The Supreme Court in Mexico City has decided in favor of Penn Mex Fuel Co. in suit brought by Nunez and Rocha for approximately 8,000,000 pesos in connection with Alamo oil property. Suit was originally instituted in Tuxpam and carried to Vera Cruz and Jalapa courts, where the case has been since October, 1924. Company's operations in the contested territory have been virtually shut down since that time. Exports by the company, stopped in May, 1925, are being resumed, with 800,000 bbls. of crude in storage at Tuxpam and Alamo.

The company will receive as its share 3,000,000 bbls. of the heavy oil production in Paciencia, being operated by Standard Oil Co. of New Jersey.

Penn Mex will drill three wells in Paso Real. Vice President Hoffman is returning to Pittsburgh to decide future drilling plans.

DIVIDEND NOTICE
Imperial Royalties Company

Will pay monthly dividend of 1½% to Preferred Shareholders on June 30. This is Dividend No. 81, and makes a total of 142% paid to shareholders.

E. S. HORN,
H. O. BLAND,
J. E. HORN, Trustees.
333 Mayo Building, Tulsa, Okla.

MYERS PUMPS
FOR EVERY PURPOSE

We have been manufacturing Myers Pumps for Every Purpose for over fifty years—a modern plant—a daily production of three pumps and over every minute during working hours—a world-wide distribution through nearly twenty-five thousand dealers, jobbers and supply houses, indicate our responsibility as well as the quality of our products. If you are interested in pumps for any service, of either large or small capacity, write us for catalog and prices.

THE F. E. MYERS & BRO. CO. Ashland, Ohio
ASHLAND PUMP AND HAY TOOL WORKS

Rubber Belts Built for 24-hour Day Service

Users of Quaker rubber belts in oil field service, know the value of their capacity and dependability on steady, continuous heavy duty, or handling wide variations in loads.
"IRONSIDES" Belt is strong and durable, fully capable of meeting all demands for power transmission—our best belt for the oil fields.

Send for belting pamphlet.

QUAKER CITY RUBBER COMPANY
Manufacturers of Daniel's P. P. P. rod packing
Main offices and factories: Wissinoming, Philadelphia.
Branches: New York Chicago Pittsburgh San Francisco

U. S. INDUSTRIAL DIAMOND CORP.

475 Fifth Ave., New York

Importers of all varieties of Industrial Diamonds

Carbon (Black Diamond) and Bort (Crystalline Diamond) for Diamond Core Drilling

Best shapes and qualities always in stock.

Parcels for examination and selection will be sent on request to reliable firms.

No Classified Section
in the World Commands the Oil Man's Attention Like That of
The OIL and GAS JOURNAL
PRODUCING REFINING MARKETING

STEEL PLATE CONSTRUCTION
Steel Oil Storage Tanks, Condensers, Stills, Refinery equipment of every kind, Fabricated and Erected
RITER-CONLEY COMPANY
General Offices—Pittsburgh, Pa.

SKINNER Clamps stop leaks
Send for Catalog
M. B. SKINNER CO., 562 Washington Boulevard, CHICAGO

Oklahoma-Kansas and Eastern Pipe Line Report

OKLAHOMA-KANSAS
Pipe Line Statement for April

Company—	Month	Daily Av.
*Prairie P. L. Co.	4,380,000	146,000
Gulf P. L. Co.	1,583,963	52,799
Texas P. L. Co.	941,632	31,388
Magnolia Pet. Co.	1,562,069	52,069
Cosden P. L. Co.	1,078,448	35,948
*Sinclair P. L. Co.	2,490,000	83,000
Empire P. L. Co.	1,041,497	34,717
*Other lines	12,720,000	424,000
Total April	25,797,609	859,921
Total March	26,152,714	843,636
Difference	355,105	16,285

Shipments

†Prairie P. L. Co.	5,484,826	182,827
Gulf P. L. Co.	1,288,099	42,936
Texas P. L. Co	645,712	21,528
Magnolia Pet. Co.	1,286,241	42,875
Cosden P. L. Co.	954,712	31,824
†Sinclair P. L. Co.	2,537,233	84,574
Empire P. L. Co.	1,177,622	39,254
*Other lines	11,400,000	380,000
Total April	24,774,454	825,818
Total March	24,880,289	802,589
Difference	115,835	23,229

Stocks

*Prairie Oil & Gas Co.	30,000,000
*Prairie P. L. Co.	2,000,000
Gulf P. L. and Gypsy Oil Co.	8,257,305
The Texas Company	1,245,791
Magnolia Pet. Co.	4,833,023
Cosden P. L. Co.	2,446,239
*Sinclair Crude Oil Pur. Co.	19,400,000
Empire P. L. Co.	2,695,213
Carter Oil Co.	14,657,522
*Other lines	10,500,000
Total April	99,083,093
Total March	96,459,101
Difference	2,623,992

*Estimated. †Prairie Pipe Line shipments include Texas crude and Sinclair Pipe Line shipments include Wyoming and Texas crude. Note—Stocks do not include approximately 3,500,000 bbls. of crude oil held in storage on private tank farms and leases and approximately 2,500,000 bbls. of Texas Panhandle crude in storage in Oklahoma and Kansas.

EASTERN PIPE LINES
Runs From Wells

In the following table will be found the regular receipts from wells by various pipe lines in New York, Pennsylvania, West Virginia, Ohio, Kentucky and Indiana for March and April:

	Mar. '27	Apr. '27
Nat. Transit	163,378.73	154,870.84
S. W. Pa. P. L.	100,592.96	88,641.89
Eureka P. L.	416,053.14	384,040.85
Buckeye P. L. (Macksburg)	360,086.67	330,728.39
Buckeye P. L. (Cleveland)	12,262.69	11,229.68
Buckeye P. L. (Lima, etc.)	126,642.07	117,721.95
Indiana P. L.	10,472.58	10,277.07
Cumberland P. L.	276,896.95	257,132.67
N. Y. Transit	24,065.99	22,203.37
Tidewater P. L.	189,659.31	178,148.47
Pure Oil	175,516.93	167,608.74
Emery P. L.	57,577.05	54,707.36
Paragon Dev.	29,944.63	27,120.07
Pittsburgh P. L.	5,324.14	5,667.22
Stoll Ref.	12,195.78	.....
Total	1,960,669.62	1,810,098.57
Daily average	63,247.41	60,336.60

Note: Indian Refining Co. also reported other receipts of 320,788.98 bbls. Paragon Refining Co. had other receipts of 114,946.43 bbls. Paragon Development had other receipts of 1,682.19 bbls. Pure Oil had other receipts of 3,751.43 bbls.

Petroleum Deliveries

The following tables exhibit the shipments or regular deliveries of various pipe lines in New York, Pennsylvania, West Virginia, Ohio, Kentucky and Indiana for March and April:

	Mar. '27	Apr. '27
Nat. Transit	371,407.93	291,282.87
S. W. Pa. P. L.	394,677.29	358,167.37
Eureka P. L.	186,306.37	165,326.49
Buckeye P. L. (Macksburg)	162,229.30	170,657.32
Buckeye P. L. (Cleveland)	1,218.35	975.08
Buckeye P. L. (Lima, etc.)	851,500.60	945,498.20
Indiana P. L.	995,741.13	963,978.82
Cumberland P. L.	128,346.88	125,745.62
N. Y. Transit	97,577.19	164,631.87
Northern P. L.	161,689.55	181,685.31
Tidewater P. L.	108,290.33	118,938.50
Pure Oil	158,078.86	181,289.98
Emery P. L.	55,643.19	56,289.21
Paragon Ref.	103,362.66	113,995.67
Indian Ref.	329,602.47	331,923.45
Paragon Dev.	35,811.95	30,782.89
Pittsburgh P. L.	5,715.31	5,626.88
Total	4,147,099.11	4,206,795.53
Daily average	133,777.39	140,226.52

Gross Stocks

The gross stocks held by various pipe lines in the oil producing sections of New York, Pennsylvania, West Virginia, Ohio, Indiana and Kentucky, at the close of March and April were as follows:

	Mar. '27	Apr. '27
Nat. Transit	987,165.64	1,122,327.78
S. W. Pa. P. L.	716,181.84	736,241.91
Eureka P. L.	1,438,177.29	1,429,347.79
Buckeye P. L. (Macksburg)	457,603.45	438,197.58
Buckeye P. L. (Cleveland)	41,573.95	42,148.71
Buckeye P. L. (Lima, etc.)	3,545,161.61	3,868,077.13
Indiana P. L.	592,302.39	598,145.91
Cumberland P. L.	583,281.33	587,606.67
Southern P. L.	458,081.93	421,389.46
N. Y. Transit	803,826.11	750,482.15
Northern P. L.	485,204.86	448,142.25
Pure Oil	498,169.44	495,796.06
Emery P. L.	7,599.54	6,418.11
Paragon Ref.	27,096.71	27,679.47
Indian Ref.	141,081.41	130,280.76
Paragon Dev.	8,085.46	6,239.54
Pittsburgh P. L.	3,449.67	3,773.55
Total	10,794,043.63	11,112,294.83
Increase	674,881.27	318,251.20

Grades of Oil

The following table shows the amount of the different grades of oil held by the eastern pipe lines at the close of March and April, showing the gross stocks of the above fields:

	Mar. '27	Apr. '27
Pennsylvania	3,731,445.01	3,761,619.39
Lima	810,425.15	839,740.90
Kentucky	1,067,209.97	1,143,953.67
Mid-Continent	5,041,917.37	5,269,128.72
Illinois	143,046.13	97,852.15
Total	10,794,043.63	11,112,294.83

Daily Average Runs

The following table shows the daily average runs of the Pennsylvania, Lima and Kentucky oil fields for the past four years:

	1924	1925	1926	1927
January	62,638	56,831	55,630	56,209
February	68,023	60,606	60,394	61,298
March	68,721	60,575	61,644	63,247
April	71,058	63,062	63,019	60,337
May	63,942	59,217	60,580	.....
June	63,230	61,270	64,131	.....
July	64,208	62,639	63,206	.....
August	59,942	59,686	61,815	.....
September	62,930	62,510	64,629	.....
October	64,976	60,995	62,704	.....
November	56,282	59,350	61,774	.....
December	55,814	57,974	58,755	.....

Daily Average Shipments

The following table gives daily average shipments from the Pennsylvania, Lima and other fields for the past four years:

	1924	1925	1926	1927
January	145,518	157,889	156,056	141,227
February	148,732	160,863	159,488	138,534
March	147,098	154,591	150,239	133,777
April	147,611	151,429	152,371	140,227
May	134,997	146,995	160,998	.....
June	143,010	149,467	160,257	.....
July	124,187	161,338	160,945	.....
August	123,120	161,730	151,929	.....
September	127,325	156,719	158,915	.....
October	133,170	145,243	161,132	.....
November	124,400	143,582	152,668	.....
December	151,392	150,162	136,428	.....

Gross Stocks

In the following table will be found the gross stocks of the various lines of the Pennsylvania, Lima and Kentucky oil fields, including oil received from other lines at the close of each month for the past three years:

	1925	1926	1927
January	11,353,276	9,859,170	9,718,003
February	11,192,924	9,579,354	10,119,162
March	11,158,297	9,438,292	10,794,044
April	11,062,082	9,805,851	11,112,295
May	11,207,562	9,531,757	.....
June	11,093,796	9,585,904	.....
July	11,067,453	9,734,687	.....
August	10,974,481	9,668,947	.....
September	10,781,753	9,432,732	.....
October	11,086,850	9,269,806	.....
November	11,068,158	9,257,667	.....
December	10,458,445	9,454,512	.....

Franklin Pipe Line Co.

The following table exhibits the condition of the Franklin Pipe Line at the close of business for the months named and not counted in the stocks and averages reported above.

1926—	Runs	Shipments	Stocks
April	3,137.40	4,519.68	12,459.02
May	2,933.29	2,096.35	13,295.96
June	3,217.62	1,655.15	14,858.43
July	3,025.86	4,075.11	13,809.18
August	2,886.59	2,121.21	14,574.56
September	2,788.18	3,373.06	13,989.68
October	2,991.86	2,307.75	14,671.25
November	2,810.60	1,664.55	15,817.31
December	2,847.52	5,561.11	13,103.72
1927—			
January	2,641.54	1,470.42	14,274.84
February	2,764.30	1,082.82	15,956.32
March	2,587.20	1,878.56	16,664.96

The Illinois Field

The following table gives the report of the Illinois Pipe Line Co. in Illinois:

Gross stocks May 1	2,476,177.30
Runs from wells	542,805.62
Other receipts	131,751.18
Regular deliveries	382,196.92
Other deliveries	479,034.86

The amount of Illinois oil run by the Tidewater Pipe Co. in April was 50,420.35 bbls. and deliveries were 62,622.57 bbls. Adding these figures to those of the Illinois Pipe Line Co. makes the runs and deliveries as follows:

1926—	Runs	Deliveries
April	610,957.04	487,604.00
May	682,416.67	498,456.90
June	693,102.34	568,054.94
July	713,490.66	490,092.82
August	701,795.92	555,766.59
September	688,798.66	516,083.96
Ocotber	681,648.96	531,467.39
November	651,263.33	498,439.37
December	668,909.53	587,947.61
1927—	Runs	Deliveries
January	621,421.03	530,085.98
February	595,831.16	476,950.71
March	727,593.91	554,947.43
April	593,225.97	444,818.49

Tidewater Pipe Co., Ltd., also delivered in April, 191,291.56 bbls.

AVERAGE DAILY RECEIPTS OF CALIFORNIA OIL AT ATLANTIC AND GULF COAST PORTS

Average bbls. per day—	ATLANTIC PORTS: Baltimore	Boston	New York	Philadelphia	Others	Total	GULF COAST PORTS: Galveston	New Orleans Port Arthur Baton Rouge Sabine Pass	Tampa	Total	Total All Ports
January	5,097	8,258	26,290	15,933	14,807	70,355	.....	.....	806	806	71,161
February	26,214	3,036	32,750	8,571	18,250	88,821	.....	.....	.....	.....	88,821
March	16,616	5,484	56,710	13,871	13,419	106,097	.....	.....	484	.....	106,581
April	12,667	4,367	47,667	15,100	13,300	93,100	.....	.....	.....	.....	93,100

AVERAGE DAILY IMPORTS OF PETROLEUM AT PRINCIPAL UNITED STATES PORTS

Average bbls. per day—	ATLANTIC PORTS: Baltimore	Boston	New York	Philadelphia	Others	Total	GULF COAST PORTS: Galveston	New Orleans Port Arthur Baton Rouge Sabine Pass	Tampa	Total	Total All Ports
January	16,032	8,226	64,387	4,065	21,064	123,774	7,903	43,629	4,123	55,645	179,419
February	12,000	14,429	87,286	5,321	26,714	145,750	4,786	46,786	2,143	3,607	57,322	203,072
March	4,677	13,161	63,484	9,226	26,129	116,677	6,742	36,268	2,419	4,871	50,290	166,967
April	22,700	9,033	62,033	6,067	26,567	126,400	5,067	18,033	.....	.....	23,100	149,500

GROSS PRODUCTION OF THE UNITED STATES FOR 12 MONTHS

(IN BARRELS)

1926—		California	Oklahoma	Texas	Kansas	Arkansas	Louisiana	Rocky Mountains	Eastern Fields	Total
May:	Month	18,667,144	14,507,003	11,940,797	3,616,640	5,482,939	2,231,938	3,459,489	3,317,000	63,122,955
	Daily average	602,166	467,968	385,187	113,440	176,869	71,998	111,596	107,000	2,036,224
June:	Month	18,269,417	14,073,510	11,782,200	3,346,470	5,064,760	2,206,830	3,437,905	3,365,000	61,546,092
	Daily average	608,981	469,117	392,740	111,549	168,822	73,561	114,597	112,167	2,051,536
July:	Month	18,743,199	14,667,483	13,983,759	3,582,267	5,019,892	2,173,813	3,336,664	3,420,000	64,917,076
	Daily average	604,619	472,822	451,089	115,557	161,932	70,123	107,634	110,323	2,094,099
August:	Month	18,765,080	14,618,236	17,093,586	3,681,436	4,878,191	2,190,739	3,457,697	3,339,500	68,024,465
	Daily average	605,325	471,556	551,406	118,756	157,361	73,896	111,538	107,726	2,194,338
September:	Month	18,104,964	14,466,510	17,580,100	3,450,060	4,603,230	2,079,840	3,141,123	3,330,000	66,755,817
	Daily average	603,498	482,217	586,003	115,002	153,441	69,328	104,704	111,000	2,225,194
October:	Month	18,966,055	15,730,689	19,001,388	3,714,627	4,625,138	2,166,559	3,071,720	3,398,000	70,664,189
	Daily average	611,808	507,119	612,948	119,827	149,198	69,889	99,088	109,613	2,279,490
November:	Month	19,173,128	16,876,950	18,593,160	3,593,490	4,299,480	2,054,911	2,842,587	3,216,000	70,649,706
	Daily average	639,104	562,565	619,772	119,783	143,316	68,497	94,752	107,200	2,354,990
December:	Month	20,276,950	17,832,908	19,753,591	3,664,156	4,266,189	2,018,784	2,668,301	3,313,000	73,823,829
	Daily average	654,095	575,868	637,212	117,876	137,619	65,120	86,752	106,871	2,381,414
1927—										
January:	Month	20,184,872	19,030,745	18,546,990	3,668,322	4,076,469	1,905,570	2,610,303	3,232,500	73,255,772
	Daily average	651,125	613,895	598,290	118,333	131,499	61,471	84,203	107,500	2,366,316
February:	Month	17,962,711	19,752,348	16,483,292	3,349,416	3,574,256	1,784,104	2,385,135	3,007,200	68,318,462
	Daily average	642,240	705,441	588,689	119,622	127,652	63,718	85,183	107,400	2,439,945
March:	Month	19,835,724	22,480,921	18,417,100	3,672,849	3,853,920	1,896,425	2,466,798	3,620,800	76,244,537
	Daily average	639,862	725,191	594,100	118,479	124,320	61,175	79,574	116,800	2,459,501
April:	Month	19,466,087	22,289,150	17,800,740	3,530,490	3,378,240	1,994,730	2,615,770	3,474,000	74,549,217
	Daily average	648,870	742,972	593,358	117,683	112,608	66,491	87,192	115,800	2,484,974
Total 12 month		228,435,324	206,356,467	200,976,703	42,760,234	53,122,704	24,696,090	35,482,492	40,133,000	831,964,014
		625,850	565,360	550,621	117,151	145,541	67,661	97,215	109,963	2,279,353

Oklahoma-Kansas and Eastern Pipe Line Report

OKLAHOMA-KANSAS
Pipe Line Statement for April

Company—	Month	Daily Av.
*Prairie P. L. Co.	4,380,000	146,000
Gulf P. L. Co.	1,583,963	52,799
Texas P. L. Co.	941,632	31,388
Magnolia Pet. Co.	1,562,069	52,069
Cosden P. L. Co.	1,078,448	35,948
*Sinclair P. L. Co.	2,490,000	83,000
Empire P. L. Co.	1,041,497	34,717
*Other lines	12,720,000	424,000
Total April	25,797,609	859,921
Total March	26,152,714	843,636
Difference	355,105	16,285

Shipments

†Prairie P. L. Co.	5,484,826	182,827
Gulf P. L. Co.	1,288,099	42,936
Texas P. L. Co	645,712	21,528
Magnolia Pet. Co.	1,286,241	42,875
Cosden P. L. Co.	954,712	31,824
†Sinclair P. L. Co.	2,537,233	84,574
Empire P. L. Co.	1,177,522	39,254
*Other lines	11,400,000	380,000
Total April	24,774,454	825,818
Total March	24,880,289	802,589
Difference	115,835	23,229

Stocks

*Prairie Oil & Gas Co.	30,000,000
*Prairie P. L. Co.	2,000,000
Gulf P. L. and Gypsy Oil Co.	8,257,305
The Texas Company	[illegible]791
Magnolia Pet. Co.	4,833,023
Cosden P. L. Co.	2,446,239
*Sinclair Crude Oil Pur. Co.	19,400,000
Empire P. L. Co.	2,695,213
Carter Oil Co.	14,657,522
*Other lines	10,500,000
Total April	99,083,093
Total March	96,459,101
Difference	2,623,992

*Estimated. †Prairie Pipe Line shipments include Texas crude and Sinclair Pipe Line shipments include Wyoming and Texas crude. Note—Stocks do not include approximately 3,500,000 bbls. of crude oil held in storage on private tank farms and leases and approximately 2,500,000 bbls. of Texas Panhandle crude in storage in Oklahoma and Kansas.

EASTERN PIPE LINES
Runs From Wells

In the following table will be found the regular receipts from wells by various pipe lines in New York, Pennsylvania, West Virginia, Ohio, Kentucky and Indiana for March and April:

	Mar. '27	Apr. '27
Nat. Transit	163,378.73	154,870.84
S. W. Pa. P. L.	100,592.96	88,641.89
Eureka P. L.	416,053.14	384,040.85
Buckeye P. L. (Macksburg)	360,086.67	330,728.39
Buckeye P. L. (Cleveland)	12,262.69	11,229.68
Buckeye P. L. (Lima, etc.)	126,642.07	117,721.95
Indiana P. L.	10,472.58	10,277.07
Cumberland P. L.	276,896.95	257,132.67
N. Y. Transit	24,065.99	22,203.37
Tidewater P. L.	189,659.31	178,148.47
Pure Oil	175,516.93	167,608.74
Emery P. L.	57,577.05	54,707.36
Paragon Dev.	29,944.63	27,120.07
Pittsburgh P. L.	5,324.14	5,667.22
Stoll Ref.	12,195.73	.....
Total	1,960,669.62	1,810,098.57
Daily average	63,247.41	60,336.60

Note: Indian Refining Co. also reported other receipts of 320,788.98 bbls. Paragon Refining Co. had other receipts of 114,945.43 bbls. Paragon Development had other receipts of 1,682.19 bbls. Pure Oil had other receipts of 9,751.43 bbls.

Petroleum Deliveries

The following tables exhibit the shipments or regular deliveries of various pipe lines in New York, Pennsylvania, West Virginia, Ohio, Kentucky and Indiana for March and April:

	Mar. '27	Apr. '27
Nat. Transit	371,407.93	291,282.87
S. W. Pa. P. L.	394,577.29	358,167.37
Eureka P. L.	186,306.27	165,326.49
Buckeye P. L. (Macksburg)	162,229.20	170,657.32
Buckeye P. L. (Cleveland)	1,218.35	975.08
Buckeye P. L. (Lima, etc.)	851,500.60	945,498.20
Indiana P. L.	995,741.13	963,978.82
Cumberland P. L.	128,346.83	125,745.62
N. Y. Transit	97,577.19	164,631.87
Northern P. L.	161,689.55	181,685.31
Tidewater P. L.	108,290.33	118,938.50
Pure Oil	158,078.86	181,289.98
Emery P. L.	55,643.19	56,289.21
Paragon Ref.	103,362.66	113,995.67
Indian Ref.	329,602.47	331,923.45
Paragon Dev.	35,811.95	30,782.89
Pittsburgh P. L.	5,715.31	5,626.88
Total	4,147,099.11	4,206,795.53
Daily average	133,777.39	140,226.52

Gross Stocks

The gross stocks held by various pipe lines in the oil producing sections of New York, Pennsylvania, West Virginia, Ohio, Indiana and Kentucky, at the close of March and April were as follows:

	Mar. '27	Apr. '27
Nat. Transit	987,166.64	1,122,327.78
S. W. Pa. P. L.	716,181.84	736,241.91
Eureka P. L.	1,438,177.29	1,429,347.79
Buckeye P. L. (Macksburg)	457,603.45	438,197.58
Buckeye P. L. (Cleveland)	41,573.95	42,148.71
Buckeye P. L. (Lima, etc.)	3,545,161.61	3,368,077.13
Indiana P. L.	592,303.39	598,145.91
Cumberland P. L.	583,281.32	587,606.67
Southern P. L.	458,081.92	421,389.46
N. Y. Transit	803,826.11	750,482.15
Northern P. L.	435,204.86	448,142.26
Pure Oil	498,169.44	495,796.06
Emery P. L.	7,599.54	6,418.11
Paragon Ref.	27,096.71	27,679.47
Indian Ref.	141,081.41	130,280.76
Paragon Dev.	8,085.46	6,239.54
Pittsburgh P. L.	3,449.67	3,773.55
Total	10,794,043.63	11,112,294.83
Increase	674,881.27	318,251.20

Grades of Oil

The following table shows the amount of the different grades of oil held by the eastern pipe lines at the close of March and April, showing the gross stocks of the above fields:

	Mar. '27	Apr. '27
Pennsylvania	3,731,445.01	3,761,619.39
Lima	810,425.15	839,740.90
Kentucky	1,067,209.97	1,143,953.67
Mid-Continent	5,041,917.37	5,269,128.72
Illinois	143,046.13	97,852.15
Total	10,794,043.63	11,112,294.83

Daily Average Runs

The following table shows the daily average runs of the Pennsylvania, Lima and Kentucky oil fields for the past four years:

	1924	1925	1926	1927
January	62,638	56,831	55,630	56,209
February	68,023	60,606	60,394	61,298
March	68,721	60,575	61,644	63,247
April	71,058	63,062	63,019	60,337
May	63,942	59,217	60,580	.....
June	63,220	61,270	64,131	.....
July	64,208	62,639	63,206	.....
August	59,942	59,686	61,815	.....
September	62,930	62,510	64,639	.....
October	64,976	60,995	62,704	.....
November	56,282	59,350	61,774	.....
December	55,814	57,974	58,755	.....

Daily Average Shipments

The following table gives daily average shipments from the Pennsylvania, Lima and other fields for the past four years:

	1924	1925	1926	1927
January	145,518	157,889	156,056	141,227
February	148,732	160,863	159,488	138,534
March	147,098	154,591	150,239	133,777
April	147,611	151,429	152,371	140,227
May	134,997	146,995	160,998	.....
June	143,010	149,467	160,257	.....
July	124,187	161,338	160,945	.....
August	123,120	161,730	151,929	.....
September	127,325	156,719	158,915	.....
October	123,170	145,388	161,132	.....
November	124,400	143,582	152,668	.....
December	151,392	150,162	136,428	.....

Gross Stocks

In the following table will be found the gross stocks of the various lines of the Pennsylvania, Lima and Kentucky oil fields, including oil received from other lines at the close of each month for the past three years:

	1925	1926	1927
January	11,353,276	9,859,170	9,718,003
February	11,192,924	9,579,354	10,119,162
March	11,158,297	9,438,293	10,794,044
April	11,062,082	9,805,851	11,112,295
May	11,207,562	9,531,757	.....
June	11,093,796	9,585,904	.....
July	11,067,453	9,734,687	.....
August	10,974,481	9,668,947	.....
September	10,781,753	9,433,732	.....
October	11,086,850	9,269,806	.....
November	11,068,158	9,257,667	.....
December	10,458,445	9,454,512	.....

Franklin Pipe Line Co.

The following table exhibits the condition of the Franklin Pipe Line at the close of business for the months named and not counted in the stocks and averages reported above.

	Runs	Shipments	Stocks
1926—			
April	3,137.40	4,519.68	12,459.02
May	2,933.29	2,096.35	13,295.96
June	3,217.62	1,655.15	14,858.43
July	3,025.86	4,076.11	13,809.18
August	2,886.59	2,121.31	14,574.56
September	2,788.18	3,373.06	13,985.68
October	2,991.86	2,307.75	14,671.36
November	2,810.60	1,664.55	15,817.31
December	2,847.52	5,561.11	13,103.72
1927—			
January	2,641.54	1,470.42	14,274.84
February	2,764.30	1,082.82	15,956.32
March	2,587.20	1,878.56	16,664.96

The Illinois Field

The following table gives the report of the Illinois Pipe Line Co. in Illinois:

Gross stocks May 1	2,476,177.30
Runs from wells	544,805.62
Other receipts	131,751.18
Regular deliveries	382,195.92
Other deliveries	479,034.86

The amount of Illinois oil run by the Tidewater Pipe Co. in April was 50,420.35 bbls. and deliveries were 62,622.57 bbls. Adding these figures to those of the Illinois Pipe Line Co. makes the runs and deliveries as follows:

	Runs	Deliveries
1926—		
April	610,957.04	487,604.00
May	682,416.67	498,456.90
June	693,102.34	558,054.94
July	713,490.66	490,082.82
August	701,795.92	555,766.59
September	688,798.66	516,083.05
Ocotber	681,648.96	531,467.39
November	651,263.33	498,439.37
December	668,909.58	587,947.61
1927—		
January	631,421.03	530,085.98
February	595,831.16	476,960.71
March	727,593.91	554,947.43
April	593,225.97	444,818.49

Tidewater Pipe Co., Ltd., also delivered in April, 191,291.56 bbls.

AVERAGE DAILY RECEIPTS OF CALIFORNIA OIL AT ATLANTIC AND GULF COAST PORTS

Average bbls. per day—	ATLANTIC PORTS						GULF COAST PORTS					Total
	Baltimore	Boston	New York	Philadelphia	Others	Total	Galveston	New Orleans Baton Rouge	Port Arthur Sabine Pass	Tampa	Total	All Ports
January	5,097	8,258	26,290	15,932	14,807	70,355	.....	.....	.....	806	806	71,161
February	26,214	3,036	22,750	8,571	18,250	88,821	.....	.....	.....	.....	.....	88,821
March	16,616	5,484	56,710	13,871	13,419	106,097	.....	.....	.....	484	.....	106,581
April	12,667	4,367	47,667	15,100	13,300	93,100	.....	.....	.....	.....	.....	93,100

AVERAGE DAILY IMPORTS OF PETROLEUM AT PRINCIPAL UNITED STATES PORTS

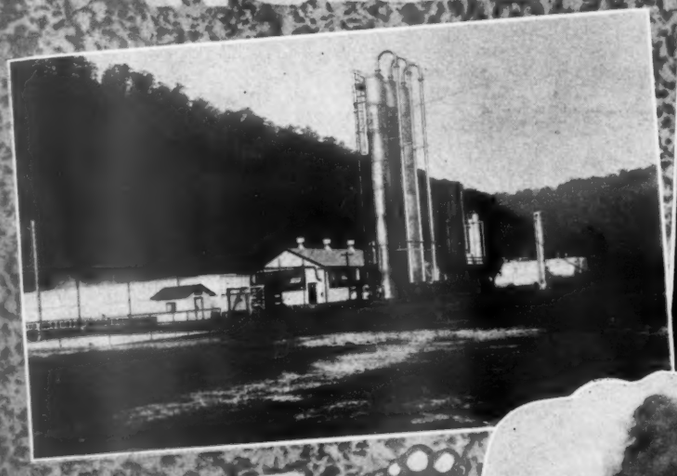
Average bbls. per day—	ATLANTIC PORTS						GULF COAST PORTS					Total
	Baltimore	Boston	New York	Philadelphia	Others	Total	Galveston	New Orleans Baton Rouge	Port Arthur Sabine Pass	Tampa	Total	All Ports
January	16,032	8,226	64,387	4,065	31,064	123,774	7,903	43,629	.....	4,123	55,645	179,419
February	12,000	14,429	87,286	5,321	26,714	145,750	4,786	46,786	2,143	3,607	57,322	203,072
March	4,677	13,161	63,484	9,226	26,129	116,677	6,742	36,258	2,419	4,871	50,290	166,967
April	22,700	9,033	62,033	6,067	26,567	126,400	5,067	18,033	.....	.....	23,100	149,500

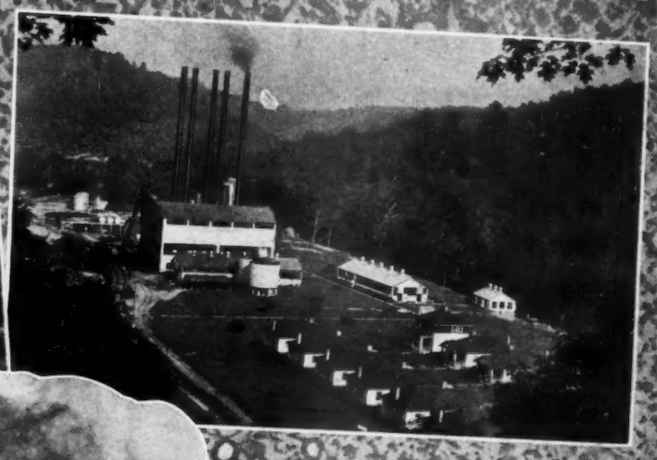
GROSS PRODUCTION OF THE UNITED STATES FOR 12 MONTHS

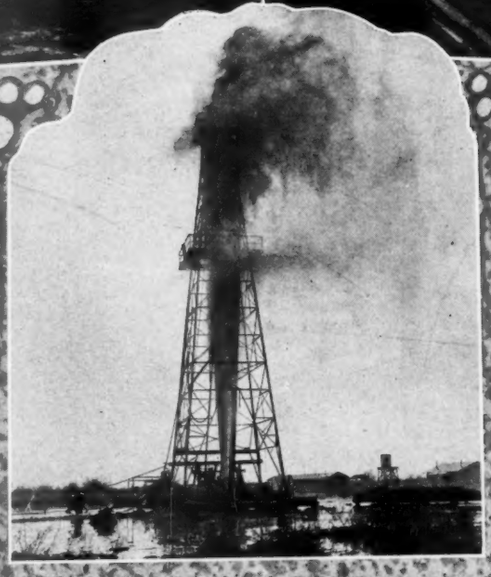
(IN BARRELS)

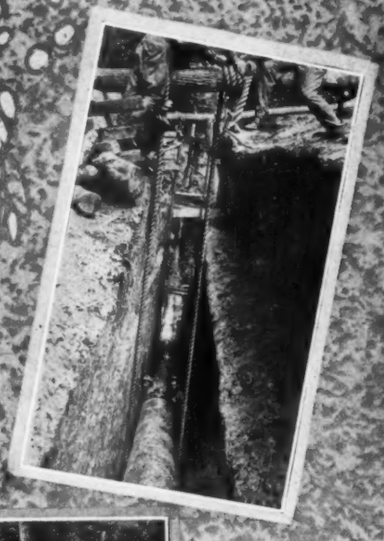
		California	Oklahoma	Texas	Kansas	Arkansas	Louisiana	Rocky Mountains	Eastern Fields	Total
1926—										
May:	Month	18,667,144	14,507,008	11,940,797	3,616,640	5,482,939	2,231,938	3,459,489	3,317,000	63,123,955
	Daily average	602,166	467,968	385,187	113,440	176,869	71,998	111,596	107,000	2,036,224
June:	Month	18,269,417	14,073,510	11,782,200	3,346,470	5,064,760	2,206,830	3,437,905	3,365,000	61,546,092
	Daily average	608,981	469,117	392,740	111,549	168,822	73,561	114,597	112,167	2,051,536
July:	Month	18,743,199	14,657,482	13,983,759	3,582,267	5,019,892	2,173,813	3,336,664	3,420,000	64,917,076
	Daily average	604,619	472,822	451,089	115,557	161,932	70,123	107,634	110,323	2,094,099
August:	Month	18,765,080	14,618,236	17,093,586	3,681,436	4,878,191	2,190,739	3,457,697	3,339,500	68,024,465
	Daily average	605,325	471,556	551,406	118,756	157,361	73,896	111,538	107,726	2,194,338
September:	Month	18,104,964	14,466,510	17,580,100	3,450,060	4,603,230	2,079,840	3,141,123	3,330,000	66,755,817
	Daily average	603,498	482,217	586,003	115,002	153,441	69,328	104,704	111,000	2,225,194
October:	Month	18,966,058	15,720,689	19,001,385	3,714,637	4,625,138	2,166,559	3,071,720	3,398,000	70,664,189
	Daily average	611,808	507,119	612,948	119,827	149,198	69,889	99,088	109,613	2,279,490
November:	Month	19,173,128	16,876,950	18,593,160	3,593,490	4,299,480	2,064,911	2,842,587	3,216,000	70,649,706
	Daily average	639,104	562,565	619,772	119,783	143,316	68,497	94,752	107,200	2,354,990
December:	Month	20,276,950	17,832,908	19,753,691	3,654,156	4,266,189	2,018,734	2,668,301	3,313,000	73,823,229
	Daily average	654,095	576,868	637,212	117,876	137,619	65,120	85,752	106,871	2,381,414
1927—										
January:	Month	20,184,872	19,030,745	18,546,990	3,668,323	4,076,469	1,905,670	2,610,303	3,232,500	73,255,772
	Daily average	651,125	613,895	598,290	118,333	131,499	61,471	84,203	107,500	2,366,315
February:	Month	17,982,711	19,752,348	16,483,292	3,349,416	3,574,256	1,784,104	2,385,135	3,007,200	68,318,463
	Daily average	642,240	705,441	588,689	119,622	127,652	63,718	85,183	107,400	2,439,945
March:	Month	19,835,724	22,480,931	18,417,100	3,672,849	3,853,920	1,896,425	2,466,798	3,620,800	76,244,587
	Daily average	639,862	725,191	594,100	118,479	124,320	61,175	79,574	116,800	2,459,501
April:	Month	19,466,087	22,289,150	17,800,740	3,530,490	3,378,240	1,994,730	2,615,770	3,474,000	74,549,217
	Daily average	648,870	742,972	593,358	117,683	112,608	66,491	87,192	115,800	2,484,974
Total 12 month		228,435,324	206,356,467	200,976,703	42,760,234	53,122,704	24,696,090	35,483,492	40,133,000	831,964,014
		625,850	565,360	550,631	117,161	145,541	67,661	97,215	109,953	2,279,353

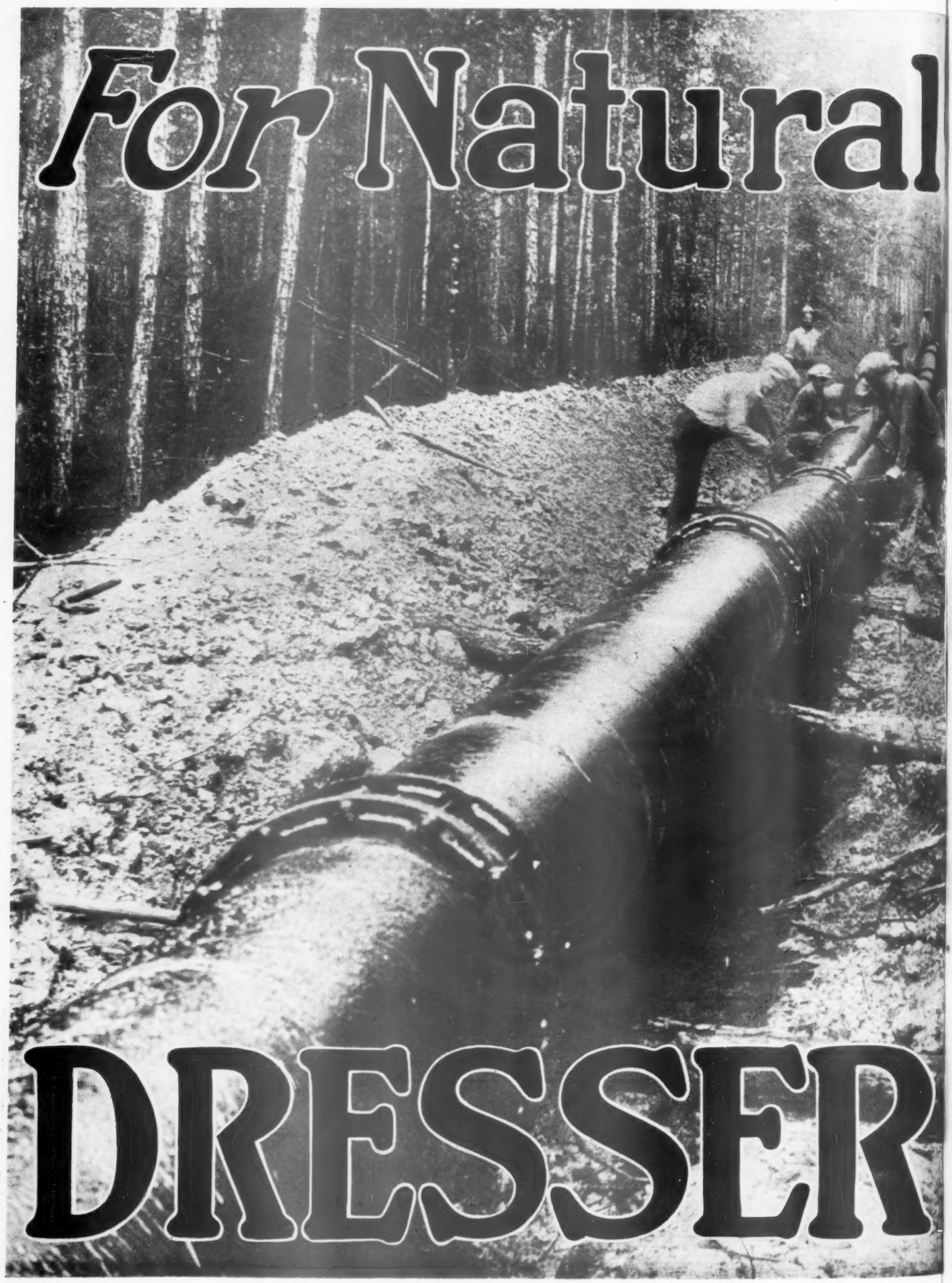
NATURAL GAS INDUSTRY OF NORTH AMERICA



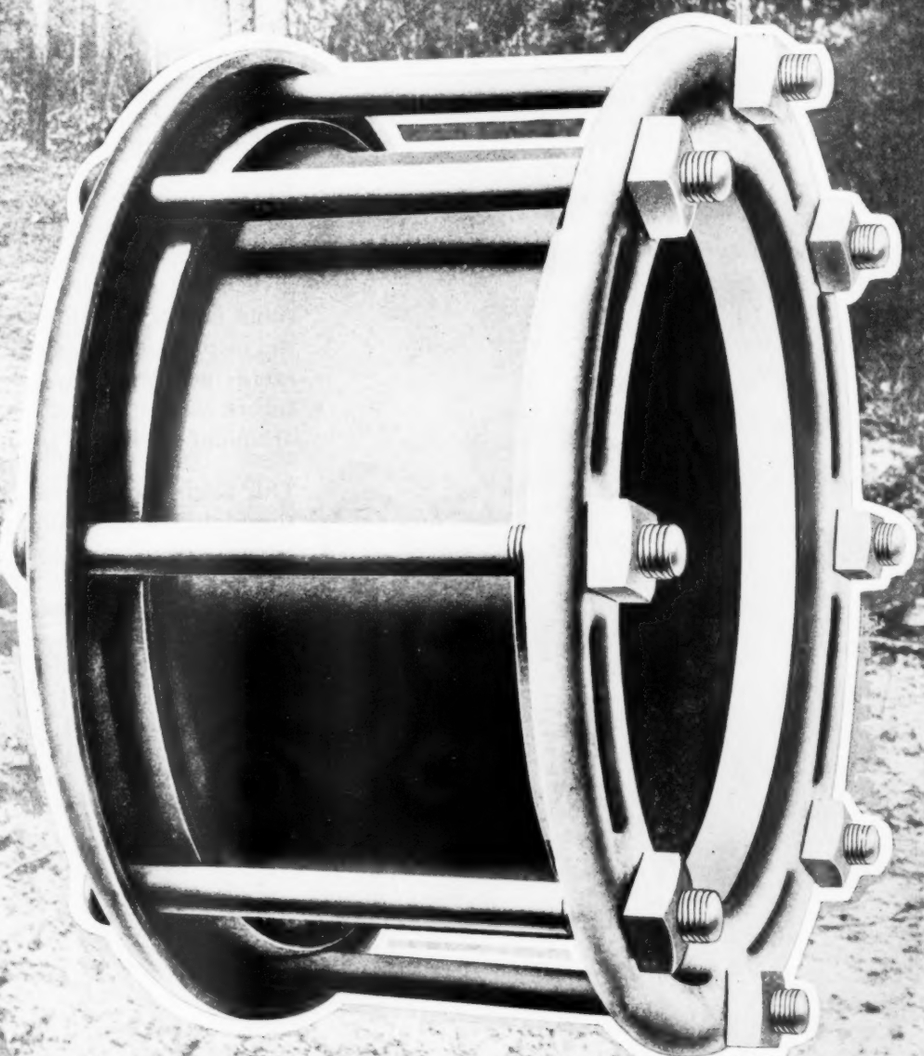







For Natural
DRESSER

Gas Lines



S.R. DRESSER MFG. COMPANY · BRADFORD, PENNA.

COUPLINGS DOMINATE!

Introducing A New Era In

METRICS These New

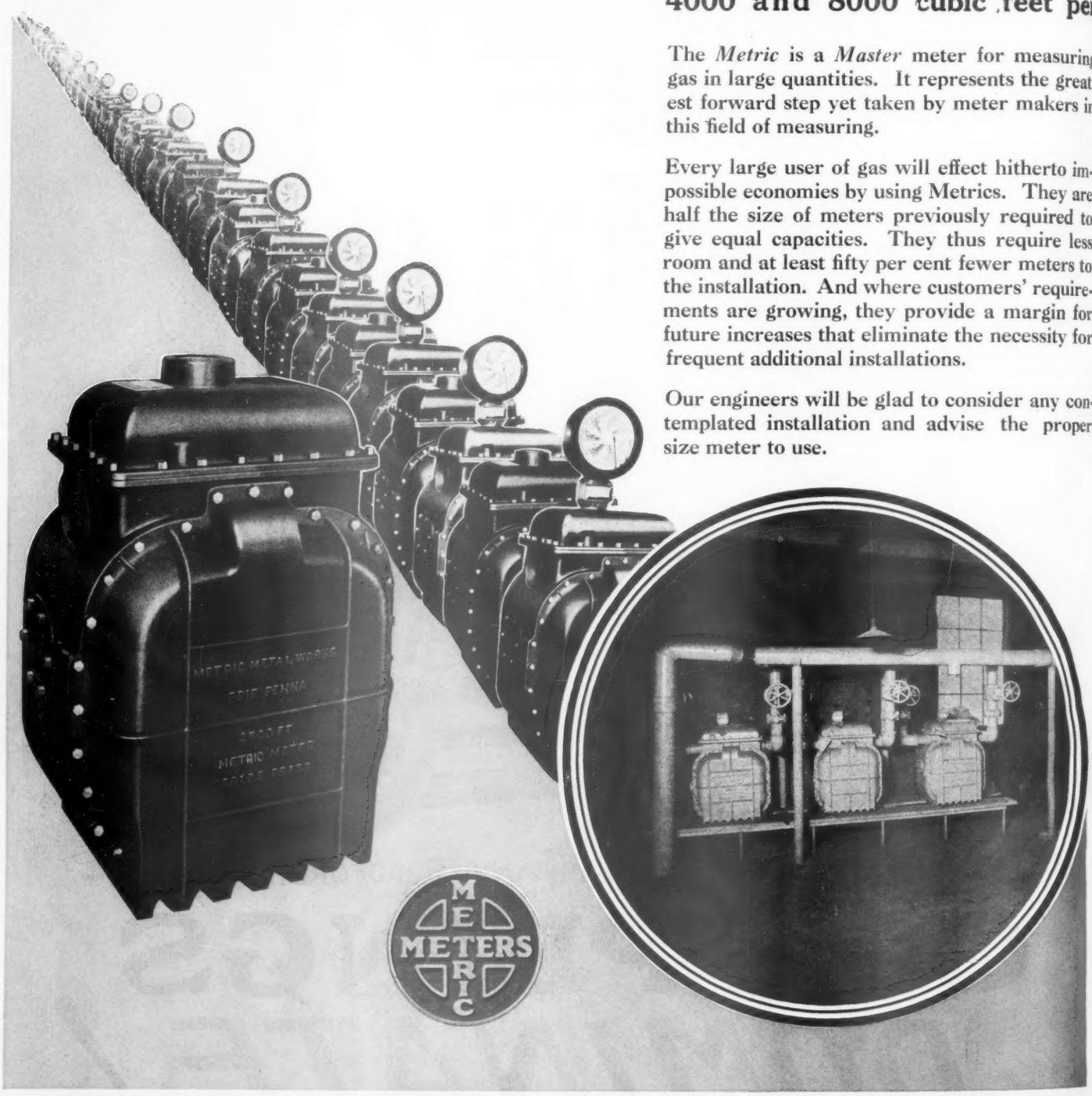
have the largest measur

4000 and 8000 cubic feet per

The *Metric* is a *Master* meter for measuring gas in large quantities. It represents the greatest forward step yet taken by meter makers in this field of measuring.

Every large user of gas will effect hitherto impossible economies by using Metrics. They are half the size of meters previously required to give equal capacities. They thus require less room and at least fifty per cent fewer meters to the installation. And where customers' requirements are growing, they provide a margin for future increases that eliminate the necessity for frequent additional installations.

Our engineers will be glad to consider any contemplated installation and advise the proper size meter to use.



Metric Metal Works *of the* American Meter Co. *Inc.* Erie, Penna.

Large Volume Measurement

Iron Meters

ing capacities available:

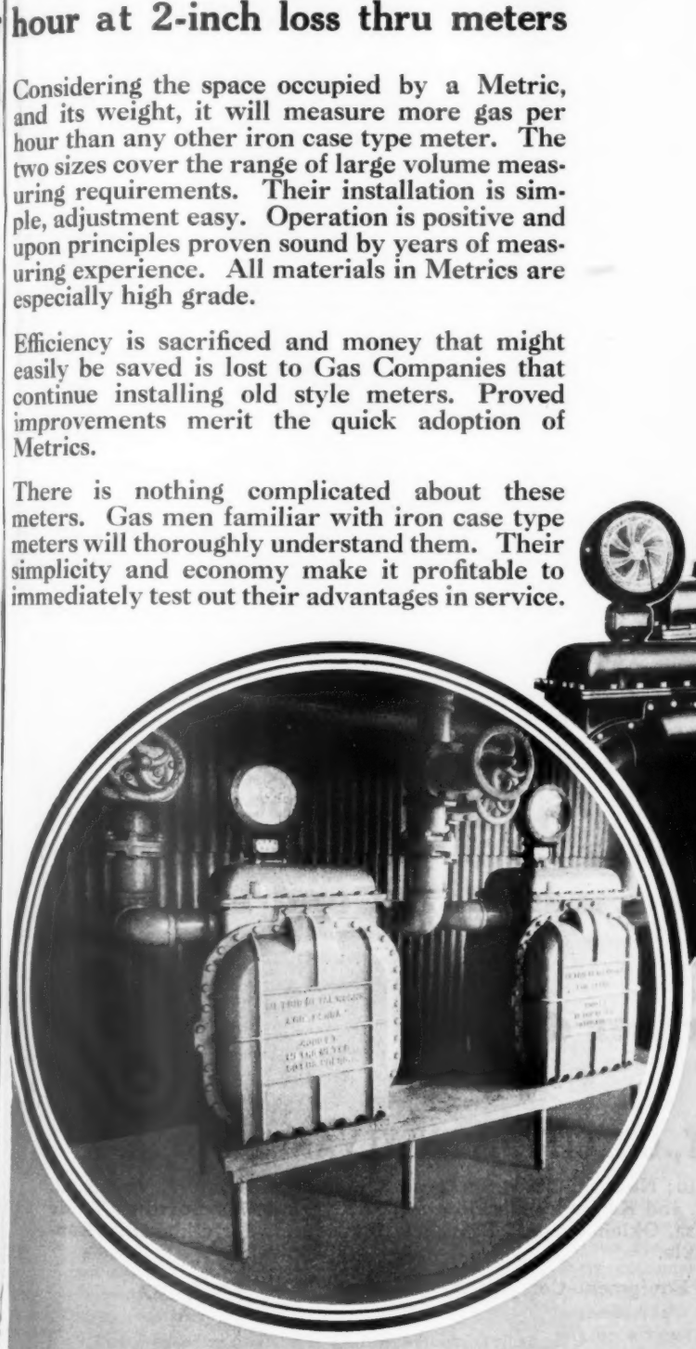
hour at 2-inch loss thru meters

METRICS

Considering the space occupied by a Metric, and its weight, it will measure more gas per hour than any other iron case type meter. The two sizes cover the range of large volume measuring requirements. Their installation is simple, adjustment easy. Operation is positive and upon principles proven sound by years of measuring experience. All materials in Metrics are especially high grade.

Efficiency is sacrificed and money that might easily be saved is lost to Gas Companies that continue installing old style meters. Proved improvements merit the quick adoption of Metrics.

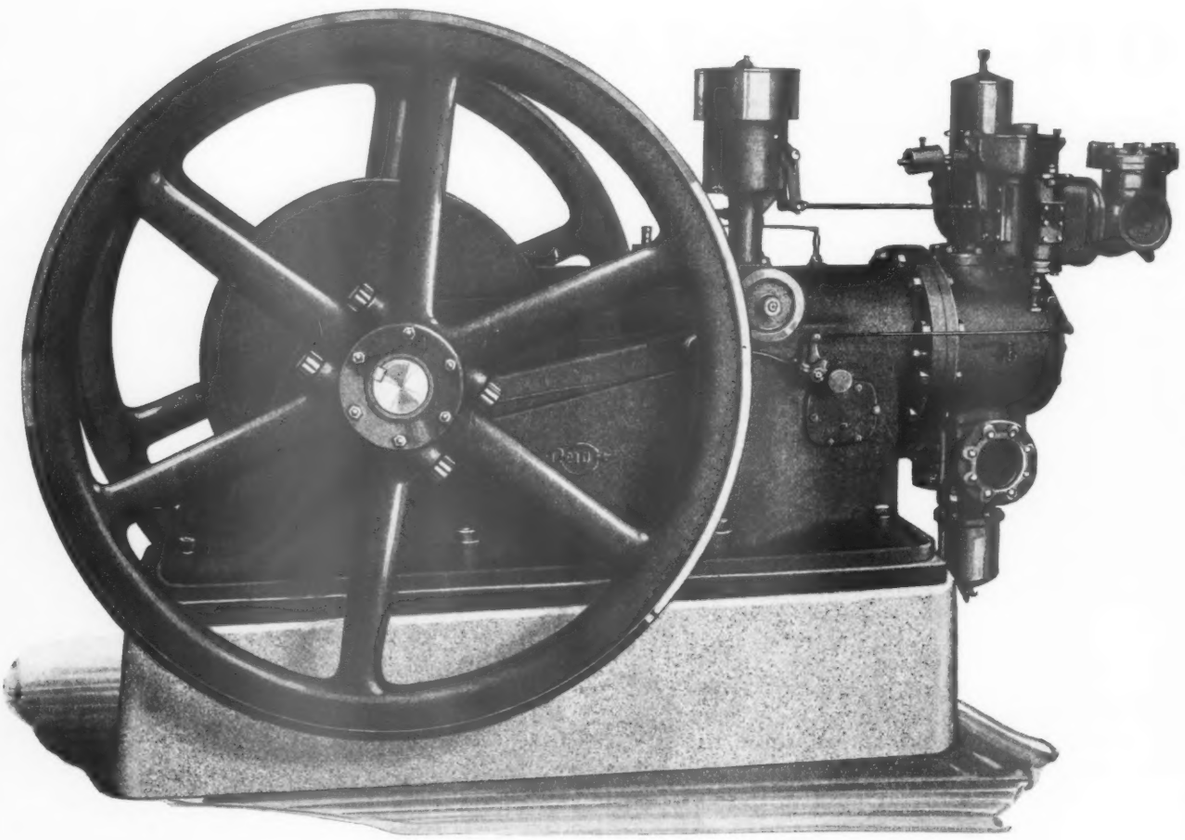
There is nothing complicated about these meters. Gas men familiar with iron case type meters will thoroughly understand them. Their simplicity and economy make it profitable to immediately test out their advantages in service.



METERS METRIC

Westcott & Greis-Sales Service ~ Dallas - Tulsa - Los Angeles

REID FOUR CYCLE GAS ENGINES



Built in two sizes—one rated 65 H.P at 150 R.P.M.—the other rated 45 H.P. at 175 R.P.M. The low operating speed is advantageous, in that large pulleys can be used, giving better belt performance. A Good Engine for compressor drives.

Write for further details.

JOSEPH REID GAS ENGINE COMPANY, OIL CITY, PENNSYLVANIA, U. S. A.

BRANCHES AND AGENCIES—Marietta, Ohio; Logan, Ohio; Newark, Ohio; Shreveport, La.; Charleston, W. Va.; R. B. Moore, Bolivar, N. Y.; Frick & Lindsay Co., Bradford, Penna., and Kentucky Distributors; S. R. Shoup, 724 Board of Trade Bldg., Los Angeles, Cal.; Frick-Reid Supply Company, Tulsa, Oklahoma, and Branches, Distributors for Oklahoma, Kansas, Texas, Arkansas and Wyoming. Branch Shop, Tulsa, Okla.

EXPORT SALES REPRESENTATIVE: Oil Field Equipment Co., Inc., 30 Church St., New York City

REID OIL FIELD MACHINERY

The Natural Gas Industry

By W. T. Anderson

The parallel between the gas industry and the oil industry is that each has seen its original market relegated to the rear while newer uses have immensely expanded the demand for its products.

In their initial stages both industries thought their future was bound up with illumination purposes. Gas light and the kerosene lamp seemed their broadest utilization. But both industries have survived the successful competition of electricity in the lighting field and have far exceeded in their development any expansion imaginable in their early days.

There are some 22,000,000 dwellings in the United States and about as many automobiles. Gas service cannot hope to be as ubiquitous as the gasoline pump but there are some 15,000,000 domestic consumers supplied with either natural or artificial gas, over 3,500,000 using natural gas and over 10,500,000 manufactured gas.

As an indication of growth there were over 92,000 new consumers of natural gas in 1925 over 1924 and over 400,000 new users of manufactured gas added in the same period, the most recent for which figures are available.

Seventy-five thousand miles of pipe line distribute the natural gas and 81,000 miles are used by the manufactured gas companies, the natural gas companies having to transport their product long distances from the fields to the consumers and the manufactured companies having their plants in the centers of population where their market is.

Domestic Consumption

Domestic consumers of manufactured gas consumed over 421,000,000,000 feet in 1925 and are increasing their demand steadily from year to year. Domestic consumption of natural gas, on the contrary, was 272,000,000,000 feet in 1925 against 285,000,000,000 the previous year, significant proof that even with more consumers there is better utilization of this precious natural product than in its wasteful early period.

Taken together, the total consumption of natural gas, by both domestic consumers and by the industries fortunate in having this perfect fuel, reached the record aggregate of 1,188,439,000,000 feet in 1925, which, added to the consumption of manufactured gas, made a grand total of over 1,500,000,000,000 feet in one year.

Yet it may be questioned if those who benefit by this use ever give the industry supplying this service any more thought than the average householder gives to the fact that he has water on tap.

In each case popular knowledge and interest ends with the idea that the gas or the water is pumped into the pipes.

This indifference to the source or method by which we obtain our utilities, conveniences and comforts is in sharp contrast with the pioneers who, by personal effort, knew the where and the how of everything they used.

Getting More Value

It may be said that it does not matter to the present-day consumer how he is served, that the details are of no consequence to him, but this is not so. Unless he has a knowledge of the value of what he is using he cannot get the fullest return from it.

The present generation is getting better service from its more limited supply of natural gas than the profligate pioneer consumers. The old saying that "you never miss the water until the well runs dry" aptly describes the experience of the consumers in the Eastern gas fields. The states which formerly ranked foremost in natural gas production are now anxiously exploring their territory for wells that may continue the vanishing supply from year to year.

As the drillers venture into remoter fields the pipe lines are extended and it must be remembered that gas lines cost $25,000 a mile, running from 16 to 20 inches against the average 8-inch oil line.

A compressor station costs about $900,000 and each booster station costs $150,000.

It is easy to see why the consumer must expect to pay more for a supply which costs so much more.

West of the Mississippi the gas companies are profiting from the experience of the Eastern field. They are carefully avoiding waste and educating and even assisting their public in proper utilization of their product.

It is essential, if we are to prolong our supply of this fast-diminishing bounty of nature, that we understand its most efficient utilization, even to eking it out with the manufactured product to make it go as far as we can.

Waste Now Avoided

The flaring flambeaux in the natural gas regions have long since disappeared. They were symbolical of the "come easy, go easy" attitude based on the mistaken belief that we had an inexhaustible store of natural gas. Egg stove burners, naked gas lights blazing night and day, have been displaced by scientifically designed equipment calculated to get the highest possible use out of every foot of gas used.

But this change was not brought about without a bitter battle. A public accustomed to gas so cheap it could be wasted and knowing and caring nothing about the source or manner of its supply refused to believe that there was a limit to it. Advances in rates, necessitated by more costly operating expenses, due to having to go greater distances to maintain supply, were resented as extortionate.

And it must be admitted that in those days utility corporations without competition had not learned the value of good will and were too often disposed to treat protests with contempt. Popular anger resulting in hostile legislation further handicapped the companies struggling with the difficulty of maintaining a rapidly declining supply and conditions were steadily getting worse when the natural gas industry took the unprecedented step of laying its case before the United States Bureau of Mines for a thorough exposition before the country.

Winning Good Will

The co-operation of the Government was secured by the National Committee on Natural Gas Conservation appointed by Secretary of the Interior Lane, a campaign of popular education was launched, through advertising, through motion picture films, in the schools, covering all phases of the production, transportation and distribution of natural gas.

The public, always ready to listen to the facts frankly presented, and encouraged by the efforts of the gas companies to win the good will of their customers, responded to this altered attitude. Gradually advances in natural gas rates commensurate with the increasing cost of keeping up a supply were approved by public authorities and accepted by the consuming public in good faith.

As a result the companies have been able to maintain better service, to prolong the use of natural gas and to aid the consumers in more efficient utilization through more effective equipment.

One of the most difficult problems of the natural gas industry arises from the fact that the domestic demand varies so widely; small in summer and high in winter but with a peak for only a few hours in the mornings and evenings. This, of course, requires the maintenance of equipment and supply equal to the maximum demand, however so short, yet demanding an adjustment throughout the year that will neither make the rates prohibitively high nor fail to give a fair return on the investment.

Industrial Use

The industrial use of gas offered a solution. As a fuel for the use of industries natural gas had exceptional advantages. It could be supplied for half the price of manufactured gas. It was the most convenient form of fuel, giving a steady, constant heat that could be regulated to all needs. The industrial demand gives employment for the equipment needed by the domestic consumers only a few hours a day in the peak season, thus enabling the companies to function without having to charge a prohibitive price to the domestic users.

A further factor which operates to the advantage of the domestic consumer is the advance made in the exploitation of gas products which to that extent lightens the burden of maintenance. The natural gasoline obtained from natural gas furnishes 11.2 per cent of the country's motor fuel. Helium has removed the hazard of inflammability from the operation of dirigibles. Carbon black is one of the essential ingredients of printing ink. It has been an invaluable aid to the motor tire industry and the motorist, serving to toughen and increase the tensile strength and resiliency of our tires, reducing the risk of punctures, so that tires have three times the life of tires before carbon black was used in their manufacture.

The Research Laboratory established by the American Gas Association at Cleveland, Ohio, which has been concerning itself largely with improving gas appliances, is also studying possible new uses and new markets, assuring the continued expansion of the gas industry and particularly more effective service.

Survey of Industry as a Whole

The natural gas industry has grown so big and so complicated that only a few of those engaged in it have had time to get a conception of it as a whole or to realize the wide variety of specialized study and effort which it represents today. Still less, of course, has the consuming public any idea of the ramifications of the activities of the industry which means so much to its convenience, comfort and progress.

It was with a view of offering such a survey of the natural gas industry as a whole, its scope, its character, its value, the bewildering mazes of its many subdivisions, engineering, chemical, technical, that The Oil and Gas Journal conceived the project of this special number presenting for the first time a complete picture of the whole natural gas business which is so closely related and bound up with the operations of the petroleum industry.

Serving 15,000,000 consumers and probably five times as many people, the natural gas and manufactured gas companies of the United States rank among the nation's leading and most useful industries. Here, for the first time, the complete range of its operations, its problems, difficulties and achievements are set forth within one cover where they can be read and preserved with gratification and pride of accomplishment.

First Events in Natural Gas Industry

Valuable Fuel Was Looked Upon as Agency of the Devil. Shortage Predicted and Conservation Urged Years Ago

By Dr. James B. Garner

Director of Research for Hope Natural and Associated Gas Companies and Senior Fellow on Natural Gas Investigations, Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pa.

When natural gas was first discovered, it was regarded as a useless, frequently inconvenient and dangerous product. It was a nuisance which had to be tolerated in the "bringing in" of water, brine or oil production. Practically every town and borough in the Pennsylvania oil regions had ordinances and regulations prohibiting the use of natural gas for lighting and heating of residences. This opposition to a gaseous fuel was based upon the misbelief that fire from gas might be more destructive of property and life than fire from any other source. It was supposed to be one of "the devil's own creatures, and one of the agencies to be used on the Last Day in the consumption of the earth and the creatures thereon by fire." The opposition to the use of natural gas as a fuel, from other quarters, was at once mercenary and selfish. A statement from one of the Pittsburgh daily papers of June 22, 1885, contained the following: "By the first of July, every iron and steel mill in the city and vicinity, with the exception of one, will be using natural gas. This will reduce soft coal consumption 38,250,000 bushels per year, or one-seventh of the yearly output in the coal mines in the regions tributary to Pittsburgh. It will throw out of employment thousands of firemen, coal heavers and ash handlers employed in the mills." At a meeting of the Chamber of Commerce of the city of Pittsburgh in the latter part of 1885, Andrew Carnegie made in substance the following statement: "One natural gas company has 335 miles of pipe line in the city of Pittsburgh and is supplying an amount of natural gas which will displace 10,000 tons of coal per day, or 3,650,000 tons per year. This amount of fuel is more than equivalent to one-third of the total coal consumption of the year 1884. Five thousand men employed in the steel mills and glass plants will be dispensed with. Natural gas makes better iron, steel and glass than coal or coal gas. It makes steam more regular, boilers last longer and fewer boiler explosions result. Up to the present time only two concerns in Pittsburgh have made any effort to economize in the use of gas."

Shortage Foreseen in 1888

In the seventh annual report (1888) of the geological survey of Pennsylvania, the following statement is made: "Gas sands, within a radius of 40 miles around Pittsburgh, underlie a populous manufacturing district where immense supplies of the newly applied fuel (natural gas) are demanded. Whenever a gas pool is discovered it is speedily taxed to its uttermost and the search for new ones is ever active. In addition to this, much of the gas that rightfully belongs to Pittsburgh is being diverted into Ohio and West Virginia. Under these circumstances, the pools are doomed to early exhaustion."

A prophetic note in the report of the Pennsylvania Geological Survey of 1889, with reference to the natural gas industry, is of interest: "The time has evidently come when the natural gas companies should insist upon a fair compensation for the gas delivered and enforce economy in using it." Here was the beginning of the program of gas conservation.

The first gas well in the United States was drilled near Fredonia, N. Y., in 1821.

The first use of natural gas as a source of light in residences and buildings was in 1824, at Fredonia, N. Y. When General Lafayette made his visit to the United States as the nation's honored guest in 1824, it was reported that "The inn at Fredonia was lighted with gas that came up from the ground."

High Spot "Firsts" in Natural Gas

The first gas well in the United States was drilled near Fredonia, N. Y., in 1821 and the first use of natural gas as a source of light in residences and buildings in the United States was in 1824 at Fredonia, N. Y.

In the early days, practically every town and borough in Pennsylvania had an ordinance prohibiting the use of natural gas for lighting and heating of residences, claiming the gas was a creature of the Devil to be used on the last Great Day in the consumption of the earth and the creatures thereon.

Opposition to the use of gas as fuel for industries developed in Pittsburgh in 1885, it being claimed such use would throw thousands of miners and mill workers out of work.

As early as 1888, a state agency began to urge conservation of natural gas and predict a shortage of this valuable fuel.

The first long-distance iron gas pipe line in the United States was a 2-inch line extending from the Newton well to Titusville, Pa., which was completed in 1872.

In 1838, Daniel Foster of Findlay, Ohio, struck gas while digging a water well. His ingenuity enabled him to utilize this strike of gas for domestic purposes. He inverted a sugar kettle in the well over the gas stream and from this kettle as a dome the gas was conveyed by wooden pipes to his fireplace where he utilized it in a burner made from an old gun barrel.

First in Pennsylvania

The first gas well in the State of Pennsylvania was that drilled by John Criswell of New Castle. Mr. Criswell was drilling for salt water near Centerville, Butler County, in 1840, when gas was struck at a depth of 700 feet. This gas was used to evaporate brine in the manufacture of salt.

In 1860, a gas well was drilled at Erie, Pa., and used as a fuel in the factories.

In 1862, natural gas was used as a fuel in drilling oil wells on Oil Creek and in one house at Petroleum Center.

The first natural gas corporation in the United States was the Fredonia Gas, Light & Water Works Co., which was organized in 1865. It was at this time that the real domestic use of gas began.

In 1867, natural gas was used as fuel at 12 houses in Oil City, Pa.

The first long distance iron gas pipe in the United States was a 2-inch one, which delivered gas from the Newton well to Titusville, Pa. This line was completed August 1, 1872.

The first use of natural gas as a fuel in the pottery industry was that at East Liverpool, Ohio, in the early seventies.

Recovery of Gasoline

In 1873, Edwin C. Bell discovered that gasoline could be recovered from natural gas by compression. This discovery was made at the time Mr. Bell collected gasoline from the gas line to the 20 horsepower boiler on the high pressure side of the regulator; he terms this "wet gas." This discovery was made on gas which came from wells owned by Milton Stewart of Titusville, 2 miles north of Petroleum Center, Pa., on the upper Benninghoff Run.

The first industrial use of natural gas as fuel in connection with iron and steel was at Leechburg, Armstrong County, Pennsylvania, in 1874.

The first man on record to conceive of piping natural gas to Pittsburgh was the late J. J. Vandegrift. By many it was not thought feasible, but this did not deter him from making the effort. Many there were who insisted that gas would not flow through a line. The pessimists of that time claimed that gas would not flow through a line. Still unconvinced that his theory was not correct, Captain Vandegrift had the gas shut off and disconnected the line and showed that it was plugged by coal miners who were fearful that if natural gas could be used as fuel their occupation as miners would be gone. After the plugs had been removed the line was connected and there was no further trouble other than that caused by the miners breaking or tearing up the line.

The first natural gas pipe line laid in the Pittsburgh district was in 1876. This was a 6-inch line to deliver gas from the Harvey well in Butler County to the iron mills of Spang-Chalfant & Co. and Graff-Bennett Co. in Sharpsville and Millvale, a distance of 19 miles.

The first gas well in the Murraysville district was the Haymaker No. 1 well, drilled to a depth of 1,600 feet, November 3, 1875. This gas well was discovered in drilling for oil. The location of the Haymaker No. 1 is on the Remaley farm.

Prohibited Use of Gas

In the early days of natural gas exploitation, practically every town and borough in the Pennsylvania oil regions had ordinances or regulations prohibiting the use of natural gas for fuel and lighting in dwellings. Opposition to a gaseous fuel was based upon the misbelief that should the gaseous fuel be used, fire from the gas might mean the destruction of a town and great loss of life.

Pew & Emerson was the pioneer gas producing and gas distribution company in Pittsburgh. This company owned the Haymaker No. 1 well and on August 20, 1882, had drilled their first well on the Fundis farm in Westmoreland county.

The first pipe line from the Haymaker well to Pittsburgh was completed late in 1883. The size of the first pipe line laid in 1882 and 1883 to the city of Pittsburgh was 5⅝ inches in diameter and 14 miles long. This line had only sufficient capacity to carry gas from this one well.

The first gas well in the city of Pittsburgh was drilled by George Westinghouse, Jr., on May 31, 1884, on his grounds between Murtland and Lang Avenues in the Twenty-first Ward. Depth 940 feet. Gas was found also at 590 and 868 feet.

The first natural gas explosion in the City of Pittsburgh occurred January 31, 1885, and was due to leaks in the mains of the Fuel Gas Co. Seventeen persons were injured.

Famous Speechley Sand

The most remarkable natural gas producing sand is the Speechley sand, discovered at a depth of 1,900 feet, April 13, 1885, near McPhersons Corner, Pine Grove, Venango County, Pennsylvania. This sand is 50 to 100 feet in thickness. Gas was piped to Oil City, Titusville and Franklin from this well.

The first carbon black plant in the United States was built by Peter Neff at Gambier, Ohio, in 1885.

The first general manager of the Standard Oil Natural Gas interests in western Pennsylvania was Calvin N. Payne, who was appointed to this position in December, 1885, "to build up and manage the natural gas business."

The first circular ever issued by a gas company in Pittsburgh, in reference to elimination of wastes and efficient appliances, was that issued by the Philadelphia Natural Gas Co. in January, 1886.

First Gas Meters

The first large scale plant for manufacture of gas meters was organized in 1888 by Calvin N. Payne and was called the Metric Metal Co.

The first natural gas rates in Pittsburgh: "Consumers are not charged according to number of cubic feet delivered and no meters are employed." Gas was delivered to factories not according to amount of gas consumed, but according to output in competition with coal. The charge for heating stoves was $2.50 per month and for open grates $2 per month.

The first increase in gas rates in Pittsburgh was on October 30, 1890, when the rates were increased 50 per cent.

The first natural gas compressing station was built and put in operation in the fall of 1890 in Murraysville, Pa., under the direction of J. N. Pew.

In 1894, the greatest well in natural gas annals in West Virginia was struck. This was called the Big Moses well on the farm of Moses Spencer, Indian Creek, Tyler County, West Virginia, September 6. The open flow measurement was 100,000,000 feet.

The first plant for the recovery of gasoline from natural gas by the compression process was that of Andrew Fasenmyer, built in 1904, almost on the site of the original Drake well.

In 1882, the value of the gas marketed in Pennsylvania was $215,000 and Pennsylvania was the only state in which gas was produced commercially.

First Absorption Plant

The first absorption pant for the recovery of gasoline from natural gas in the United States was built at Hastings, W. Va., by the Hope Natural Gas Co., of which John G. Pew of Pittsburgh was general manager, in 1913.

The first gas well in Pennsylvania was 700 feet.

The first oil well was 69 feet deep.

The presence of helium in natural gas was first established by Cady and McFarland in 1907. The first plant for the extraction of helium from natural gas was erected at Fort Worth, Tex., in the spring of 1918.

The first charcoal absorption plant was built in 1919 at Lewis Run on the property of the United Natural Gas Co.

The first really deep natural gas producing well was completed November 27, 1924, under the supervision of John B. Tonkin, vice president of the Peoples Natural Gas Co., near Latrobe, Pa., depth 7,740 feet.

Many Areas Benefit from Natural Gas

Oklahoma Leads in Production and Consumption, With California Second. Great Advance Made in Conservation

By George Otis Smith
Director, United States Geological Survey

A map showing natural gas fields in the United States is published on pages 10 and 11.

The Federal Oil Conservation Board has referred to the waste of natural gas as a triple waste. The board's report of last year called attention to the fact that the gas dissipated by letting the oil wells produce wide open is valuable for the large quantities of natural-gas gasoline it contained as well as for the fuel value of the dry or spent gas, but that perhaps of even greater moment than these commodity values is the part natural gas plays as "the efficient agent provided by nature for bringing the oil within the reach of man." And practical men in the oil business indorsed the dictum of the Federal board that "the longer gas is retained in solution the larger is the recovery of oil." The attention given to this phase of the conservation discussion by the technical press has been noteworthy, and it is significant that the first impulse toward remedial and regulative legislation have been in terms of gas control and oil-gas ratios. "Newly discovered or at least more widely recognized facts regarding the role of gas in the oil sands" are being made the starting point for radical changes in oil field practice.

In the possession of natural gas as one of its great resources, the United States stands unique among the nations. Producing about 95 per cent of the natural gas consumed in the world, we are natural monopolists in gas, alongside of Russia in platinum, of Germany in potash, and of Chile in nitrate.

Efforts at Conservation

In 1920 the Secretary of the Interior called a Natural Gas Conference, in the hope that reason and logic might get the better of the argument and waste give place to wise use. Yet with the continuing increase in the consumption of natural gas for the country as a whole it is hard to oppose the optimism of the average citizen who believes that the unseen reservoirs must possess unlimited capacity.

A few outstanding geographic and economic facts may be noted that indicate wide departures from the averages for the country as a whole. Natural gas is a commodity that cannot be stored above ground to any appreciable extent, nor can it be transported except within the state of origin and to adjacent states. Hence the geographic facts of distribution and state output here play a more important part than in the economics of its associate, petroleum.

The general fact of a steady increase in total production of natural gas in the United States does not contradict the fact of a nearly steady decline for the past 10 years in a state like Pennsylvania, the "mother state of natural gas." Even in California, with its sixfold increase in 10 years, the curves of production, utilization, and of active meters as pointed out a year ago by the State Oil and Gas Supervisor "show the decided trend of declining production and increasing demand and leaves no doubt as to the importance of conserving and protecting from damage the known deposits of natural gas." The same report specifically urges conservation measures to prevent underground wastage of gas and the efficient protection of dry gas zones, for future use in the production of oil.

Trend Is Westward

The trend of discovery and development of natural gas has been decidedly westward. The country's increase in production of natural gas was about 58 per cent during the decade 1916-1925, for which the Geological Survey and the Bureau of Mines have furnished figures, but the output of the two leading states of 1916, West Virginia and Pennsylvania, dropped off approximately 40 per cent and 20 per cent, respectively, in the 10-year period. Ohio showed nearly the same percentage of decline as West Virginia, while Indiana and Illinois together showed no change. New York, however, lost more than 20 per cent. Thus there has been a decline in consumption of more than one-third during this period for this group of six industrial states.

The rapid increase in production and use of natural gas during these 10 years in the Mid-Continent Field and California has been spectacular. Kansas has lost heavily as a producer, though gaining as a consumer of Oklahoma gas, but Oklahoma has doubled its output; Louisiana has increased its output fivefold, California sixfold, Texas more than eightfold and Arkansas nearly eighteenfold.

Value of Natural Gas

In the same period the average value of natural gas at points of consumption is reported to have increased from 16 cents to 22.3 cents. The total value of this best of fuels in 1925 was $265,000,000.

The accompanying map of the United States showing gas areas is fairly indicative of the present-day commercial importance of the natural gas industry in the several states. Oklahoma leads by a large margin in the quantity of gas produced and consumed. California, however, with its smaller areas as shown on the map, maintains second place, and West Virginia, Louisiana, Texas and Pennsylvania follow in the order named. These half dozen states in 1925 produced nearly 85 per cent and consumed 74 per cent of the country's total output of natural gas. About one-sixth of the natural gas produced in 1925 entered interstate commerce, and 75 per cent of this interstate gas was contributed by two producing states, West Virginia and Oklahoma, to their next-door neighbors.

The increase in utilization of natural gas has been both rapid and steady. In 1908 when the state geologist of West Virginia appealed for more general appreciation of its value—21,000 wells in the United States were producing 402,000,000,000 feet; 10 years later 39,000 wells had practically doubled that output. Now another 402,000,000,000 feet has been added, making the present annual output 1,200,000,000,000 feet or more. While earlier the proportion of two to one held between industrial and domestic, it is now more than three to one. More significant, however, is the fact that the number of domestic consumers of natural gas has increased faster than the quantity consumed in domestic use. Thus ever-increasing numbers of citizens—more than 3,500,000 in 1925—are enjoying the advantages of the best of fuels.

Most gratifying from the viewpoint of national conservation is the greater recovery each year of gasoline from natural gas. In 1911, 7,500,000 gallons were extracted from natural gas and last year more than 1,350,000,000 gallons—these are the bare figures showing the growth of a by-product industry in 15 years. The present output of natural-gas gasoline is thus about 10 per cent of the output of refinery gasoline—an addition to the supply of motor fuel far more important than any substitute in sight.

Active Co-operation of Gas Industry Made This Special Number Possible

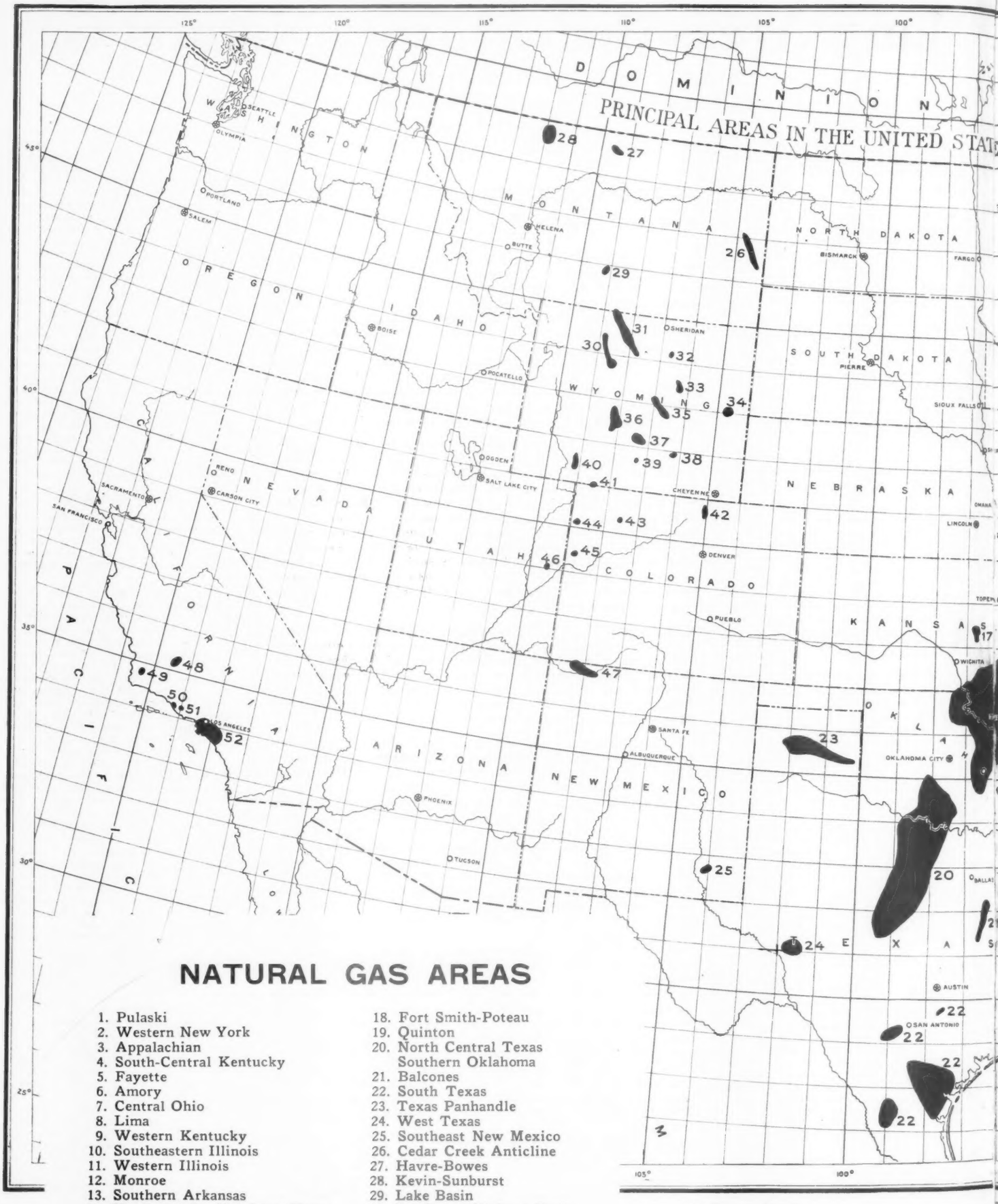
Demonstrating to the fullest extent its watchword, "Service," the natural gas industry of the United States and Canada co-operated wholeheartedly with The Oil and Gas Journal in the preparation of this special number devoted to the Natural Gas Industry of North America. For many years the natural gas industry has been a shining example in the petroleum world of the wisdom of presenting fully all facts regarding its problems to the public, knowing that the American public is inherently fairminded and that when it realizes the difficulties besetting any industry serving the public, it will co-operate and aid in the solving of these problems and in placing the industry on a sound footing.

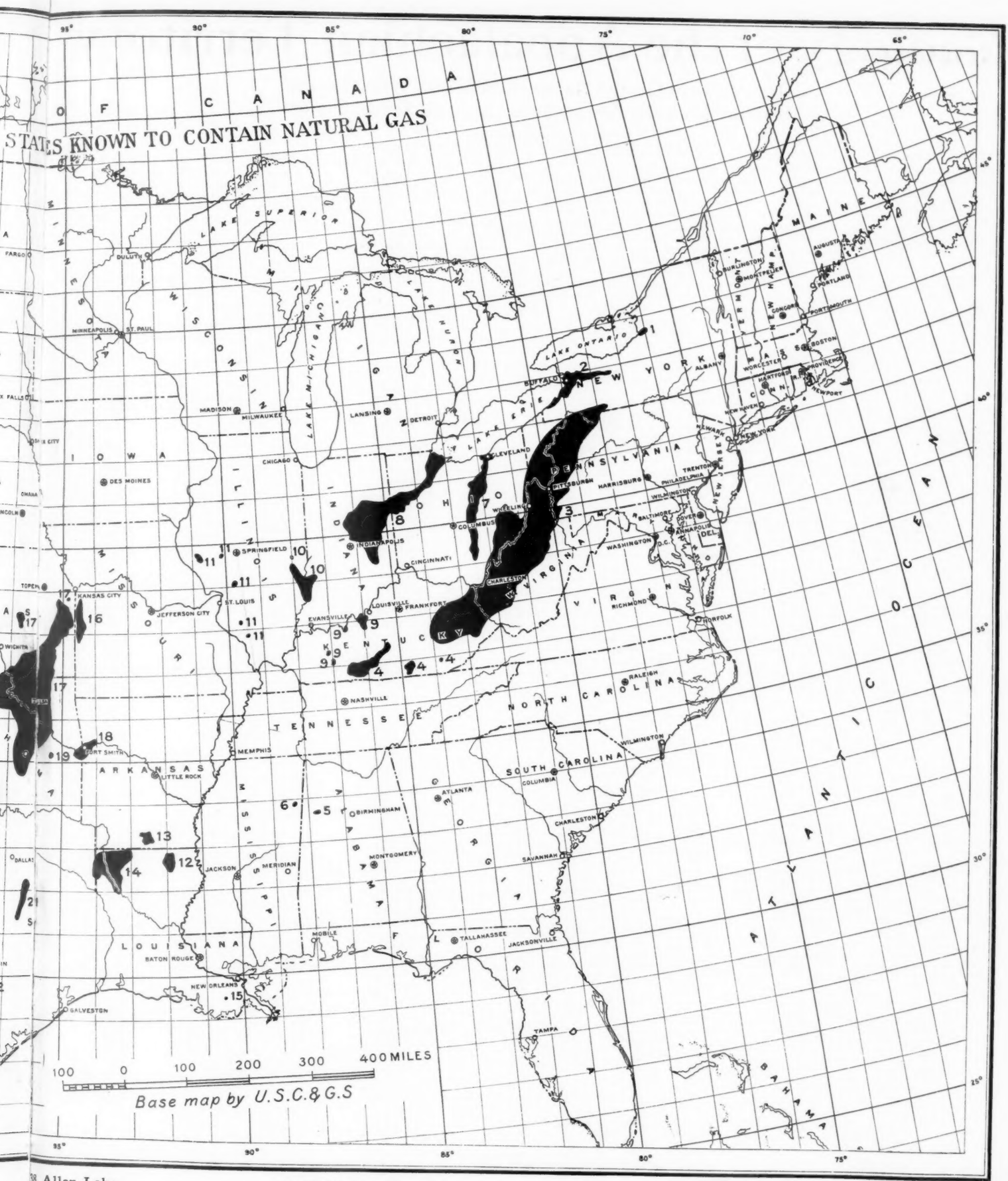
The desire of The Oil and Gas Journal to present in one issue an accurate and comprehensive picture of the business which serves more than 3,500,000 families in the United States and a large number of industries, met with a most hearty response on the part of the industry. Officials of the different natural gas companies in various sections of the country not only gave generously of their time and experience in outlining the different subjects to be covered but recommended men who had made intensive studies of these subjects as authors, and urged these men, all of whom were extremely busy with their own work, to take the time necessary to prepare the articles desired.

As a result, the different articles in this special number were written by men recognized throughout the natural gas industry as experts on the subjects treated by them. The natural gas industry desired that this issue be a veritable handbook and to achieve that object, national figures in the industry sponsored the number and used their personal influence to procure the different articles.

To name the men to whom credit is due for whatever service this number performs for the natural gas industry would mean presenting a list of the officials of the leading gas companies in the country. However, especial credit is due to many because of the time devoted to and the personal interest shown in this issue. Among these are Mr. Christy Payne, president of the Hope, Peoples and affiliated companies; Mr. John B. Corrin, vice president and general manager of the Hope, Reserve and other companies; Mr. Ralph W. Gallagher, president of the East Ohio Gas Co.; Mr. A. W. Robertson, president, Mr. A. Hurlburt, vice president and Mr. George E. Whitwell, general manager of the Equitable Gas Co.; Mr. John B. Tonkin, vice president and general manager, Peoples Natural Gas Co.; Mr. N. C. McGowen, president Natural Gas Association of America and president of the Palmer Corporation, Shreveport, La.; Mr. J. D. Creveling of the Doherty interests; Mr. A. B. Macbeth, executive vice president of the Midway and Southern California Gas Companies of Los Angeles, Calif., and president of the American Gas Association; other officials of that association; John G. Pew, vice president in charge of natural gas properties, Columbia Gas & Electric Corp.; to different officials of the United States Bureau of Mines and Geological Survey in Washington and in the Bartlesville, Okla., station of the Bureau of Mines; and to officers and members of the American Association of Petroleum Geologists.

Dr. James B. Garner, director of research of the Hope Natural and affiliated gas companies and Senior Fellow on Natural Gas Investigations, Mellon Institute of Industrial Research, University of Pittsburgh, was of such valuable assistance in the preparation of this number, The Oil and Gas Journal gave him the title of "Editor-in-Chief of the Natural Gas Number."


PRINCIPAL AREAS IN THE UNITED STATES
NATURAL GAS AREAS
1. Pulaski
2. Western New York
3. Appalachian
4. South-Central Kentucky
5. Fayette
6. Amory
7. Central Ohio
8. Lima
9. Western Kentucky
10. Southeastern Illinois
11. Western Illinois
12. Monroe
13. Southern Arkansas
14. Northwest La.-Northeast Texas
15. Terrebonne
16. Western Missouri
17. Northeast Oklahoma-Kansas
18. Fort Smith-Poteau
19. Quinton
20. North Central Texas
Southern Oklahoma
21. Balcones
22. South Texas
23. Texas Panhandle
24. West Texas
25. Southeast New Mexico
26. Cedar Creek Anticline
27. Havre-Bowes
28. Kevin-Sunburst
29. Lake Basin
30. Southwest Bighorn Basin
31. Northeast Bighorn Basin
32. Billy Creek
33. Salt Creek-Teapot
34. Lance Creek
35. Central Wyoming
36. West Central Wyoming
37. Lost Soldier



38. Allen Lake
39. Hatfield Dome
40. Baxter Basin
41. Hiawatha
42. Wellington-Fort Collins
43. Thornburg
44. Rangely
45. Garmesa
46. Cisco
47. Northwest New Mexico
48. Midway-Elk Hills
49. Santa Maria
50. Ventura Avenue
51. South Mountain
52. Los Angeles Basin

Geology of the Appalachian Territory

Occurrence of Oil and Natural Gas Shown With Detailed Information as to Sands, Structures and Other Factors

By J. French Robinson
Geological Engineer, Peoples and Affiliated Natural Gas Companies

Geology is that branch of science which treats of the earth comprehensively as a subject of research and study. It endeavors to account for the varied surface features, for its atmosphere, for the distribution of land and water, its rivers, lakes and seas, its mountains and planes. Geology studies these features in the light of varied forces and agencies operating upon them, and attempts to show their history during long ages. It takes account of the material composing the earth, and from the remains of the plants and animals still in the rocks it aims to present a picture of the successions of living organisms which have existed during the past ages down to the present time.

Geology is essentially an historical science—it continually seeks to determine the origin of things in the changes which they have experienced. The documents upon which the history is based are written in the rocks of the earth, and in the forms of its surface features. They present a series of inconvertible records and if we read this history, we must first learn to deciper the records correctly. Much has been done, but much also remains to be done.

There are many divisions of geology, any of which afford plenty of thought for a lifetime study. This is especially true of the oil and gas geology.

Not Lake-Like Deposits

Oil and gas are mixtures of hydrocarbons and usually exist in the pore space of sedimentary rocks. Oil and gas do not exist in large bodies or lake-like deposits beneath the earth's surface as many people believe. It is confined in sandstones, limestone, conglomerates and sometimes shale, termed "sands" by the driller.

The sands from which we obtain oil and gas are not unlike those we see exposed along a road or railroad cut, they are solid ledges of stone.

Since 1804 many theories have been advanced as to the origin of oil and natural gas, but to date no one theory has been actually proven. The two most commonly accepted theories are the "inorganic" and the "organic." The theory that oil and gas has been formed by inorganic processes, in one form or another, has been advanced by many chemists; their assumption is, that water or gas is in the earth acting upon chemical compounds, which generate the hydrocarbons that accumulate near the earth's surface at favorable places. This theory is attractive because it suggests processes by which oil and gas may be continuously forming; the supply being replenished in part as they are used. Notwithstanding its attractiveness, the theory of inorganic origin of oil and natural gas has not been accepted by many field engineers or geologists, because of the many difficulties which it encounters in actual practice. Petroleum reservoirs are generally tightly sealed. The rocks that have been nearest the interior of the earth, the igneous and crystaline schists, are nearly everywhere barren of oil and natural gas. I believe that a large number of eingineers and geologists hold to the organic theory or the decomposition of animal or vegetable matter for the formation of oil and natural gas. This material was laid down and covered over by the sediments of the sea, underwent decomposition, and transformation due to the heat being generated when the old earth was buckled, twisted, folded and faulted into all conceivable shapes. A detailed discussion of the origin of oil and natural gas will not be given in this paper, it will be assumed that the writer holds to the origin of oil and natural gas by the organic theory.

The purpose of this article is to give the reader a general picture and familiarize him with a few of the most important phases of the geology of the great Appalachian oil and gas field.

The Appalachian Area

The Appalachian oil and gas field includes all of the oil and gas producing districts in the United States, east of central Ohio, and northeast of central Alabama. The states which make up this great oil and gas territory are New York, Pennsylvania, West Virginia, a portion of Ohio, Kentucky, Tennessee and Alabama. This field which was the first great oil and gas field in the world to be extensively developed, still produces about 27,600,000 bbls. of oil and 342,000,000,000 cubic feet of natural gas annually.

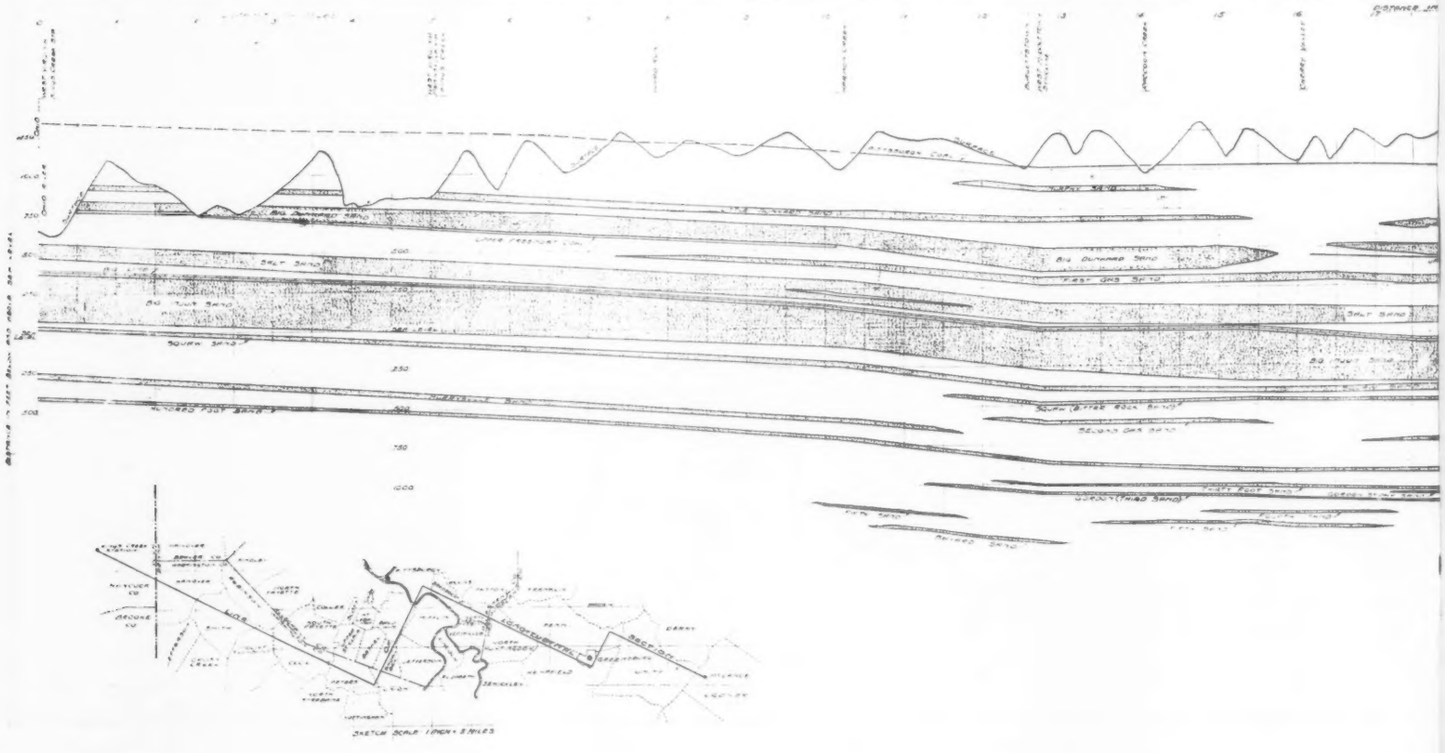
Figure 1 is an outline map of the Appalachian oil and gas field, showing the distribution of oil and gas pools in the different states. While the Appalachian oil and gas field covers a very large area, it is no longer the most important as far as production is concerned, as it supplies a little less than 30 per cent of the United States' production in natural gas, and about 4 per cent of the petroleum production of the United States. Most of the well-known oil fields and many of the gas fields in the Appalachian section, have now passed their peaks and are producing but very small quantities of both oil and gas. This is especially true of New York, Pennsylvania, and West Virginia. Much prospecting has been done recently in Tennessee and Kentucky. The petroleum and natural gas obtained from the Appalachian Field has been of high grade, and is free from objectionable impurities. The oils are the simplest in composition and are capable of yielding products of the highest grade at a minimum refining cost. The Kentucky and Tennessee oils are inferior to those of Pennsylvania and West Virginia, due possibly to their lesser degree of natural refining.

Some of the larger fields are found in the flat level districts, while many others are found in or adjacent to rough mountain country. The Appalachian oil and gas field is not unlike the other large oil and gas fields of the United States, to the extent that it is also adjacent to a great uplift; in fact, it lies just west of the Appalachian Mountain system.

Occurrence of Oil and Gas

Oil and gas are usually found confined in the pore space of sandstone and conglomerates or limestones. Some gas, however, has been found in shale deposits. The surface indications of oil and gas in the Applachian Field are not numerous. Oil was discovered seeping from the ground at Oil Springs, Allegany County, New York, and along Oil Creek, Venango County, Pennsylvania. Gas was noted from seeps at Burning Springs, Wirt County, West Virginia, and along faults in Kentucky and Tennessee. Gas has also been noted bubbling from the surface in Ohio, West Virginia and Pennsylvania. In early days oil was encountered in salt wells and salt pits and was considered a nuisance. The oil was gathered by the early settlers and made use of for medicinal purposes.

There appears to be a definite relation between the fixed carbon ratio of coals and the production of oil and gas in the same fields. This relation has been very helpful in searching for new oil and gas production, and the extension of old oil and gas fields in the Appalachian section.



A continuation of this cross-section is contained on pages 16 and 17.

The term "carbon ratio" used by David White, United States Geological Survey is applied to the percentage of carbon in pure coal after the water and ash have been eliminated. It is necessary to compute the ratio by dividing the fixed carbon of the proximate analysis by the sum of the fixed carbon and volatile matter of the same analysis. Many thousands of proximate analysis of coals in the Appalachian Field has been made. Isocarb maps have been prepared and published by individual states in one form or another.

From the detailed study of the available data, it would seem that oil production would occur when the carbon ratio in the surface coals does not exceed 60 and that the upper limits for gas production would be where the ratio does not exceed 70. For a specific locality or place more narrow limits can be used but the above expresses the general terms of the theory.

Production of Oil and Gas

The production of petroleum west of the Mississippi exceeded that east of the Mississippi for the first time in 1904. It is of interest to note that until 1875, Pennsylvania, which is a part of the Appalachian oil and gas field, produced practically all of the petroleum in the United States, and about 88 per cent of that produced in the world. In 1881, Pennsylvania produced 26,800,000 bbls. of oil, while the total production of the United States was 27,700,000 bbls. and the world's production amounted to 32,000,000 bbls. Pennsylvania reached its maximum annual production of oil in 1891 with 31,400,000 bbls. This was about 58 per cent of the production of the United States, or 34.6 per cent of the production of the world. Pennsylvania's maximum yearly production of natural gas was in 1906, the production amounting to 138,161,385,000 cubic feet. West Virginia reached its annual maximum production of oil in 1900, with a production of 16,200,000 bbls. West Virginia's maximum annual production of natural gas was in 1917 with a production of 308,600,000,000 cubic feet. New York State's maximum yearly production of natural gas was in 1914, and amounted to 9,000,000,000 cubic feet. Ohio's maximum production of natural gas was in 1916, with approximately 70,000,000,000 cubic feet. Kentucky's yearly maximum production of gas was in 1922, and was approximately 6,000,000,000 cubic feet. In 1918, Tennessee reached its maximum annual production of natural gas with 1,860,000,000 cubic feet. No separate records are available for the State of Alabama, but its production is rather small. The Appalachian oil and gas field reached its maximum annual production of natural gas in 1917, with a total of 522,200,000,000 cubic feet. The oil production for the same district reached its maximum in 1900, with 36,300,000 bbls.

Stratigraphy

Production in the Appalachian oil and gas field is obtained from a wide range of horizons in the geologic column, and includes those of the Carboniferous, Devonian, Silurian, Ordovican and Cambrian Systems. The pools or fields generally occur in the axis or flanks of anticlines or small terraces or other structural features associated with them, and in water-free synclines.

Figure 2 represents the aerial geology of the Appalachian Field. It will be seen that the older rocks come toward the surface in all direction from southwestern Greene County. The figure shows that most of the outcropping strata within the Appalachian oil and gas field are that of the Carboniferous.

Table No. 1 gives the general stratigraphic relation of the various horizons in the Appalachian Field, as well as the principal oil and gas horizons, their thickness and their respective places within the geologic column.

The formations of this region are chiefly made up of shales, coals, limestones, conglomerates and sandstones. The strata vary in character, so that a section taken at one place differs materially from that taken at another place. There are, however, certain persistent and well-recognized strata that can be used to correlate from one section to another.

The Washington, Waynesburg, Pittsburgh, Freeport and Kittanning coals occur over a vast area of the northern Appalachian oil and gas fields, and their identifications are easily determined; in fact, they afford and ideal marker or keybed upon which to base one's structure. The Ames, the Vanport, and the Big Lime also exist over a large area and are much used in working geologic structure as they afford good markers on the surface, and their character being hard, are easily determined when encountered by the drill.

Field a Great Geosyncline

The Appalachian oil and gas field is a great geosyncline or bowl-shaped structure that lies west of the Allegheny Front, and extends from New York State to Alabama. See Figure 3 for General Structure Contour Map of the Appalachian oil and gas field, which shows the elevation of the Pittsburgh coal horizon above sea level. Deep well locations are also shown on this map, the numbers of which refer to data compiled in Table No. 2, of this report. It can be seen that the strata are so folded as to resemble an oblong bowl with its axis extending in a general northeast and southwest direction; the center of which is near Wileyville, Wetzel County, West Virginia. This is the lowest point structurally in the Appalachian Field; the Pittsburgh coal is about at sea level or nearly 1,300 feet lower than it is at Pittsburgh, Pa. The various horizons rise in all directions from this point. They are, however, distributed by other foldings upon the major fold; some of which are the Burning Springs-Volcano-Eureka anticline, the Wick anticline, the Arches Fork anticline, the Murrysville anticline, the Warfield anticline, the Chestnut Ridge anticline, and the Laurel Ridge anticline. In southern West Virginia and Kentucky, the subordinate folds become less pronounced toward the northwest, the beds rising gradually toward the west. They are exposed along the Cincinnati anticline in Ohio, eastern Kentucky and Tennessee. The same is true going eastward. All of our known producing horizons outcrop in central Pennsylvania, eastern West Virginia and Maryland. The rise to the north is more gradual, the Berea sand outcropping at Corry, Pa., and the Gordon sand outcropping at Salamanca, N. Y. Nearly all of the folds extend in a general northeast and southwest direction, that is, paralleling the Allegheny Front. The Burning Springs-Volcano-Eureka uplift being an exception as its general direction is north and south.

Geologic structure outlines the hills and the valleys, beneath the surface as topography outlines the surface conditions. The mountains or hills geologically are called "anticlines," the low points or troughs are called "synclines," that is to say an anticline represents the high point of a structure, similar to the crest of a wave. The syncline represents the trough or low point, such as the low point of a wave.

There are two general methods of representing geologic structure; one is by means of contours, see Figures 5, 6 and 7, and the other is by cross sections, see Figure 9. In gently folded areas and those free of faults, the contour method is preferred to the cross section method.

Differs From Other Fields

Production of both oil and gas in the Appalachian Field is unlike that of most fields, in so far that it is obtained from so many different horizons and at varying places on the geologic structure. Structure plays one and a very important part in finding and developing oil and gas fields, not to the extent, however, that every time one finds an anticline or a large structure that he is sure of production. If this were true, Appalachian geology would be simple, but this is not the case. Water and sand conditions play an important role in production of the Appalachian Field. Hence, it behooves the geological engineer to keep very accurate records in regard to water and sand conditions. Most of the companies in the Appalachian Field ignore these principals. It is true that we get dry holes just one location away from large wells, but the time is fast approaching when the oil and gas operators in the Appalachian Field must use more scientific methods in locating and caring for their wells. Some of the larger operators in the Appalachian Field are drilling about 37 per cent dry holes while others are getting from 16 per cent to 20 per cent dry.

Structure affords a condition whereby segregation of water, oil and gas takes place. If water is present, and it usually is in the shallow sand, it will be found in the syncline or trough. Oil may be found on the slopes or terraces above the water, and if there be no water in the sand, oil may be found in the syncline. Gas being the lighter will generally be

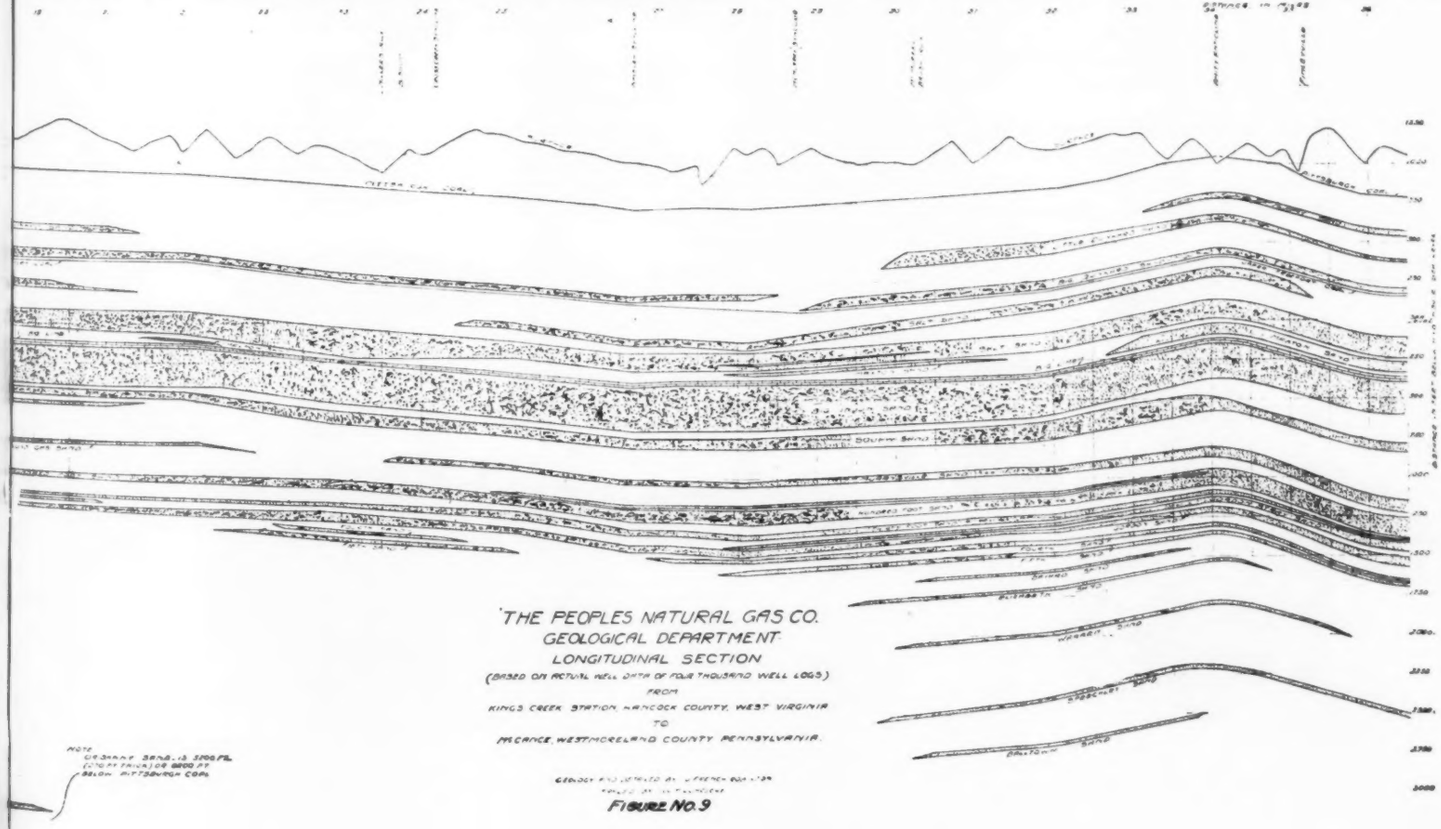
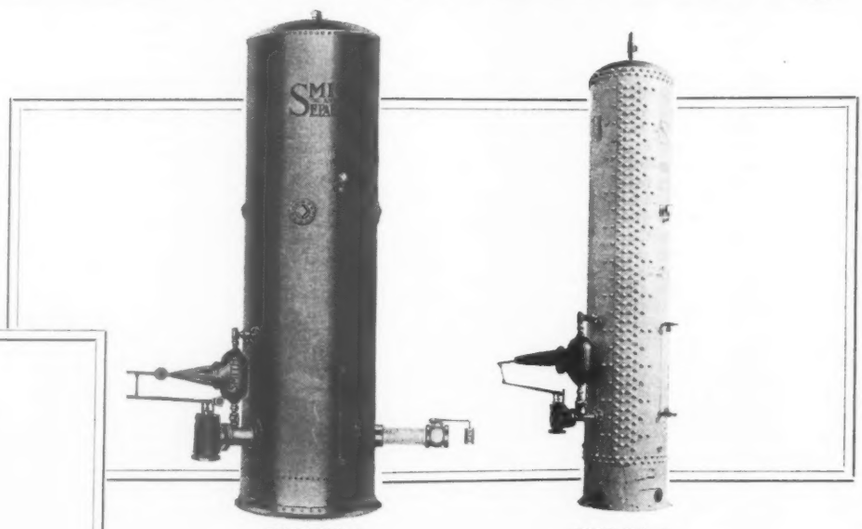

THE PEOPLES NATURAL GAS CO.
GEOLOGICAL DEPARTMENT
LONGITUDINAL SECTION
(BASED ON ACTUAL WELL DATA OF FOUR THOUSAND WELL LOGS)
FROM
KINGS CREEK STATION, HANCOCK COUNTY, WEST VIRGINIA
TO
PRINCE, WESTMORELAND COUNTY, PENNSYLVANIA.

FIGURE NO. 9

Equipment for the Gas Industry

There's a style and type of Smith Oil and Gas Separator to meet any production condition . . . in any field, anywhere.

Smith Oil and Gas Separators are recognized as standard equipment by the leading oil producers.



TYPE NO. 1
6,000 bbls. oil,
15,000,000 ft. gas.

TYPE NO. 6
1,500 bbls. oil,
20,000,000 ft. gas.
15-inch vacuum to
500 lbs. pressure.

The Smith Separator catalogue should be in your files. It is filled with information valuable to every producer.

Smith Oil and Gas Separators

Smith Oil and Gas Separators have developed steadily with the growth of the Industry. Our engineers have worked with the producers in developing a line of oil and gas separators that will successfully handle every production condition in any field, anywhere in the world.

SMITH SEPARATOR COMPANY
Tulsa Okla.

NEW YORK OFFICE:
Export Representative:
Oil Field Equipment Co.,
30 Church St., New York
Cable Address:
"Oilfields," New York
CALIFORNIA OFFICE
2039 East 38th St.,
Los Angeles, Calif.
LOUISIANA OFFICE:
405 Forest Ave.,
Shreveport, La.

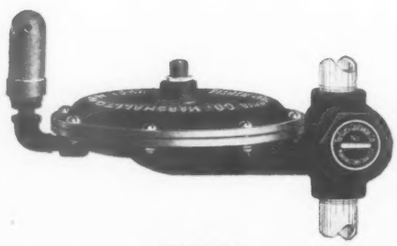
LONDON OFFICE:
Perkins MacIntosh Petroleum Tool & Boring Co., Ltd.,
25 Bishopsgate
Cable Address:
"Oleborers," London
TEXAS OFFICES:
924 Post Dispatch Bldg.,
Houston, Texas
1402 Ft Worth Nat'l Bank Bldg.,
Fort Worth, Texas

Fisher Equipment

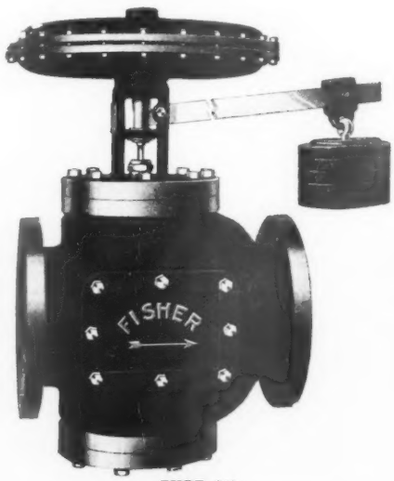
Fisher Equipment, developed to successfully meet the needs of the industry, is used today almost universally by producers and refiners the world over.

Built up to a high quality standard, of the finest materials by expert workmen, Fisher Equipment has won its eminent position in the Industry on performance alone.

TYPE 212
This specialty is built with increased outlet valve bodies for medium and high pressure service. It is suitable for hot or cold natural or artificial gas, hot or cold air, or other gaseous fluids.



TYPE 206
Type 206 is a low pressure house service gas regulator. It is used also to reduce pressure on individual gas engines.

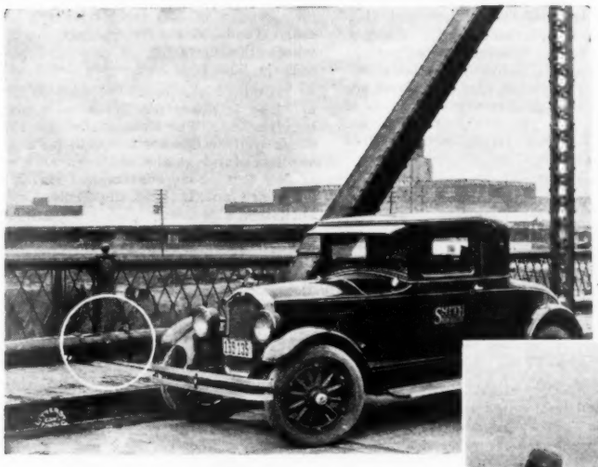


TYPE 210
Type 210 is generally used for reducing the gas pressure in distribution mains, reinforcing lines, or service mains. As a low pressure regulator on such service it will maintain a gas pressure of a few ounces regardless of normal pressure pulsations on the inlet side of regulator. This type is simple in design, has few working parts, and is ruggedly built for severe service.

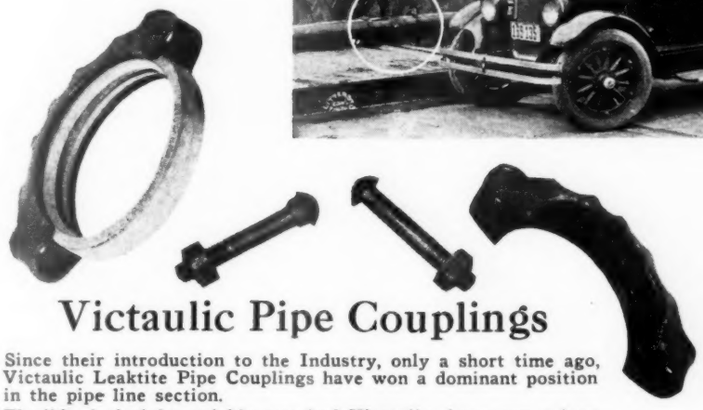
Equipment for the Gas Industry

When the Houston Gas Company laid their line over the Houston Drawbridge, Victaulic Joints were selected because of their ability to remain leak-proof under the severe vibration to which the bridge was subjected.

Photo at the right shows the pipe line carried on the floor of the bridge with Victaulic Joint within the white circle.



The photo below shows the south end of the bridge where the line comes up to cross over on the bridge floor. The gentleman in the photo is Mr. Geo. Waverly, Superintendent of the Houston Gas and Fuel Company.



Victaulic Pipe Couplings

Since their introduction to the Industry, only a short time ago, Victaulic Leaktite Pipe Couplings have won a dominant position in the pipe line section.

Flexible, leak-tight, quickly attached Victaulics have won a host of friends among pipe line companies as well as everywhere else in the Industry where pipe is used.

Victaulic Leaktite Pipe Couplings will prove under your own test that they are the most satisfactory and the most economical joints you have ever used.

SMITH SEPARATOR COMPANY

Tulsa Okla.

NEW YORK OFFICE:
Export Representative:
Oil Field Equipment Co.,
30 Church St., New York
Cable Address:
"Oilfields," New York

CALIFORNIA OFFICE
2039 East 38th St.,
Los Angeles, Calif.

LOUISIANA OFFICE:
405 Forest Ave.,
Shreveport, La.

LONDON OFFICE:
Perkins MacIntosh Petroleum Tool & Boring Co., Ltd.,
25 Bishopsgate
Cable Address:
"Oleborers," London

TEXAS OFFICES:
924 Post Dispatch Bldg.,
Houston, Texas
1402 Ft Worth Nat'l Bank Bldg.,
Fort Worth, Texas

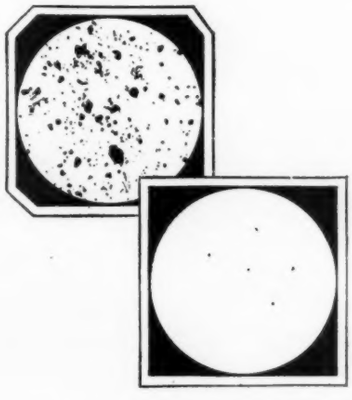
Reed Air Is Clean Air

Clean air is just as essential to the long life of engines and compressors as to your lungs.

Dust, dirt and abrasive substances, drawn into the working parts cause wear and resulting shut-downs.

Reed air filters will cleanse the air of all foreign substances, lengthen the life of your engines and compressors and quickly pay their cost in the saving of repairs and shut-down time.

Air filtered through a Reed Air filter is clean air free from dirt, dust and abrasive substances. And clean air means less wear to the engine and compressor mechanism.



The micrograph above shows the dust content of ordinary air as compared with the "Reed Filtered Air" after more than 97% of the dust, soot and grit has been removed by filtration.

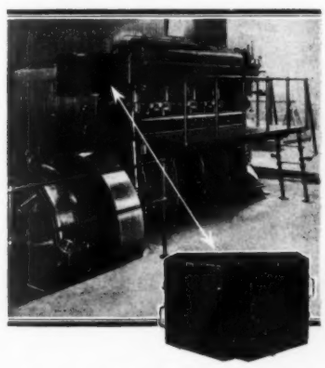


Photo shows a Reed Air Filter installed on a Diesel Engine in power plant. This is a typical installation, used by engine and compressor users.

found high on the slopes or on the dome, when oil or water or both are in the sands. If there be neither oil nor water in the sands, gas may be found in the syncline. Each sand is a problem within itself. For example: One sand may produce gas in the syncline and another sand produce oil at a location higher on the slope due to the fact that there be neither oil nor water in the first sand, but both in the second. See Figure 4 for illustration.

Since geologic structure plays such an important part in obtaining production, it is necessary to have the structure worked in detail over the territory which is being, or is likely to be operated throughout the Appalachian Field. Many of the states have published maps showing in general the structure in that vicinity. The United States Geological Survey has published folios covering a large part of this territory, in which are maps showing the structure. This data answers the purpose for reconnoissance survey but for all detail study it is necessary to work the geologic structure more accurately. Much detail geologic structure in the Appalachian oil and gas field has been done by the various oil and gas companies.

Figure 5 shows the detail structure map of Whitley, Perry, Wayne and a portion of Dunkard, Franklin, Center and Greene Townships in Greene County, Pennsylvania, and Cass, Clay and Battelle districts in Monongalia County, West Virginia as worked by the writer. This structure is based upon the elevation of the Pittsburgh coal bed above sea level, and has been obtained by records of various oil and gas wells and diamond core tests,—actual levels being run to the wells and location of core tests.

As formerly stated the structural low point in the Appalachian Field is at Wileyville, Wetzel County, West Virginia. As one looks at the structure on Figure 5, it is evident the general dip is to the southwest. This dip is however distributed by other foldings.

The Belle Vernon anticline begins just south of the Pennsylvania-West Virginia state line where the Pittsburgh coal has an elevation of 350 feet above sea level, and extends in a northeasterly direction where the elevation of the Pittsburgh coal is 650 feet above sea level.

As one looks eastward the Whitley syncline is observed. This is a plunging syncline. The elevation of the Pittsburgh coal at the north is 540 feet above sea level, and at the southern extremity is 340 feet above sea level. Many gas wells are noted along the Belle Vernon anticline, also many gas wells are seen along the northern end of the Whitley syncline, but very little gas production is noted along the southern portion of this syncline. The Moorseville anticline brings the Pittsburgh coal to an elevation of 460 feet above sea level.

In the southeastern portion of Figure 5, a basin (The Lambert syncline) brings the Pittsburgh coal to an elevation of 410 feet above sea level. From this basin it rises to the southeast where the elevation of the Pittsburgh coal is 750 feet above sea level.

It is of interest to note that the oil production is found below the 360-foot contour in the southwestern part of this map, and that it is produced between the 440 and 460-foot contours along the Mooresville anticline, and that the oil production east of the Lambert syncline

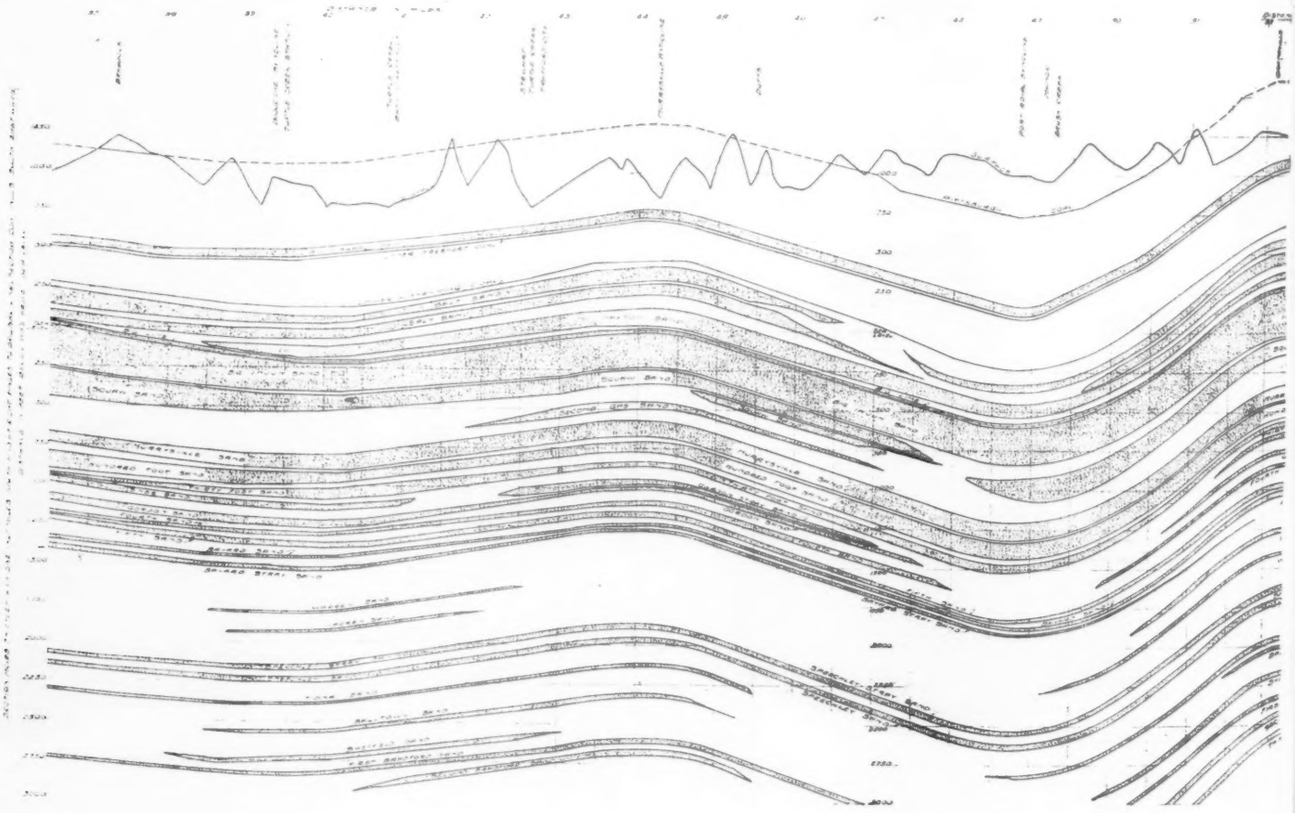
TEMPERATURE TES T OF DEEP WELLS

Name of well—	Location (See Fig. 3)	Depth in Feet 100	500	1,000	1,500	2,000	2,500	3,000	3,500	4,000	4,500	5,000	5,500	6,000	6,500	6,750	6,760	7,000	7,250	7,310
Ligonier	No. 9	50.7	55.8	63.0	70.6	78.6	85.9	93.0	100.8	107.8	117.2	127.4	137.8	148.7	158.3	166.1	166.3			
Geary	No. 7	57.0	59.9	63.1	68.1	75.0	81.1	86.9	95.5	103.1	109.2	119.8	132.0	140.0	142.8			145.0		
Goff	No. 18	55.6	60.2	65.3	67.3	74.9	81.0	87.6	93.8	100.0	107.2	114.2	122.3	132.1	143.2			153.2	157.7	158.3
Volcano	No. 12	52.0	57.4	64.5	68.8	75.9	83.6	91.0	98.9	106.0	112.5	117.5								
Terra Alta	No. 15	53.0	56.1	62.9	70.0	77.2	87.3	96.0	108.5	115.6										
Smith	No. 28	57.0	60.3	65.4	68.2	76.1	81.0	88.0	93.5	100.0	106.5	107.0	120.5	132.5						
La Mont	No. 26	46.0	51.3	58.0	63.9	70.9	77.6	85.3	92.8	101.8	110.1	119.0	130.0							

Note—All temperatures shown in degrees Fahrenheit.

TABLE NO. 2—SUMMARY OF DEEP WELL OPERATIONS IN THE APPALACHIAN OIL AND GAS FIELDS, By

No.	Name of Well	Drilled By	Location	Date Completed	Elev.	Carboniferous: Pittsburgh Coal	Carboniferous: Berea Top	Carboniferous: Berea Bottom	Devonian: Bradford or Benson of W. Va. Top	Devonian: Bradford or Benson of W. Va. Bottom	Devonian: Corniferous Lime Top	Devonian: Corniferous Lime Bottom
1	Presque Island	City of Erie	Erie County, Pa.	1910	....		....	....	....	....	....	....
2	Derrick City	United Natural Gas Co.	McKean County, Pa.	....	1,585		....	....	1,120	1,198	4,065	4,135
3	Spiritualist		Potter County, Pa.	....	....		....	....	....	....	....	....
4	Rockdale	United Natural Gas Co.	Crawford County, Pa.	1921	1,170		....	....	....	....	2,852	3,025
5	Selberling		Akron, Summit County, Ohio	1905	....		300	385	....	....	....	....
6			Canton, Stark County, Ohio	....	....		....	....	....	....	....	....
7	Geary	Peoples Natural Gas Co.	McDonald, Washington County, Pa.	1917	1,050	Starts 130 feet below	1,610	1,612	4,100	4,170	6,008	6,045
8	J. S. Lightcap	Phillips Gas Co.	Indiana County Pa.	1920	....		1,015	....	....	....	....	....
9	Ligonier	Peoples Natural Gas Co.	McCance, Westmoreland County, Pa.	1925	1,122		388	475	2,470	2,488	6,786	6,807
10	Lancaster	Federal Fuel & Gas Co.	Lancaster, Ohio	....	....		442	467	....	....	....	....
11	George Handchsy	Zanesville Oil & Gas Co.	Muskingum County, Ohio	....	....		1,010	1,033	....	....	....	....
12	Volcano	Hope Natural Gas Co.	Wood County, W. Va.	1919	1,256		905	906	....	....	....	....
13	Kendall Lumber Co.	Hope Natural Gas Co.	Monongalia County, W. Va.	1919	....	Starts 2,000 feet below	....	....	....	....	....	....
14	Accident	Pittsburgh Syndicate	Garret County, Md.	1922	2,400		....	....	....	....	....	....
15	Terra Alta	Hope Natural Gas Co.	Preston County, W. Va.	1925	2,020		....	....	1,456	1,495	....	....
16	Parsons	Parsons Pulp Co.	Tucker County, W. Va.	....	1,650		....	....	....	....	3,825	3,845
17	Lake	Hope Natural Gas Co.	Marion County, W. Va.	6/18/19	1,201	Starts 850 feet below	1,000	1,025	3,420	3,428	6,956	7,018
18	Goff	Hope Natural Gas Co.	Harrison County, W. Va.	1918	1,164	Starts 200 feet below	1,512	1,540	4,166	4,167	7,363	7,386
19	Youngsville		Warren County, Pa.	....	....		....	....	....	....	....	....
20	Bennett Heirs	Hope Natural Gas Co.	Gilmer County, W. Va.	1917	875		2,300	....	....	....	....	....
21	Slaughter Creek	Edwards Oil Co.	Kanawha County, W. Va.	....	....		2,093	2,105	....	....	4,945	5,035
22	Templeton	Nixon Oil & Gas Co.	Cabell County, W. Va.	1924	....		2,123	2,140	....	....	....	....
23	At Paddle, W. Va.		Wayne County, W. Va.	....	....		....	....	....	....	....	....
24	Central City		Cabell County, W. Va.	....	....		....	....	....	....	....	....
25	William Bedell	Forest Oil Co.	Allegheny County, Pa.	1898	..	Starts 130 feet below	1,515	1,565	3,500	3,520	....	....
26	La Mont	United Natural Gas Co.	Elk County, Pa.	....	1,841		110	....	2,108	2,148	5,308	5,476
27	Laurel Ridge	U. S. Research Co.	Cambria County, Pa.	....	....		....	....	....	....	....	....
28	Smith	Reserve Gas Co.	Harrison County, W. Va.	....	1,054	Starts 100 feet below	1,625	....	....	....	....	....
29	Big Run	Cliff Deemer	Jefferson County, Pa.	....	....		800	....	2,800	....	....	....
30	Tidioute	Fidelity Petroleum Corp.	Tidioute, Forest County, Pa.	....	....		....	....	....	....	4,280	....
31	Buidekaper		Conneaut Lake, Pa.	....	....		275	300	....	....	....	....
32	Mayton Lumber Co.	Hope Natural Gas Co.	Middle Fork District, Randolph County, Pa.	1918	....		1,700	1,725	....	....	....	....



is between the 520 and the 580-foot contours,—thus the oil pools are very well defined by structures.

Figure 6 shows the elevation of the Clinton sand below sea level, just east of Zanesville, Ohio. This structure is based on actual elevations run to the various wells and use made of well records.

It will be noted that this structure is a monocline rising towards the west at the rate of about 80 feet to the mile.

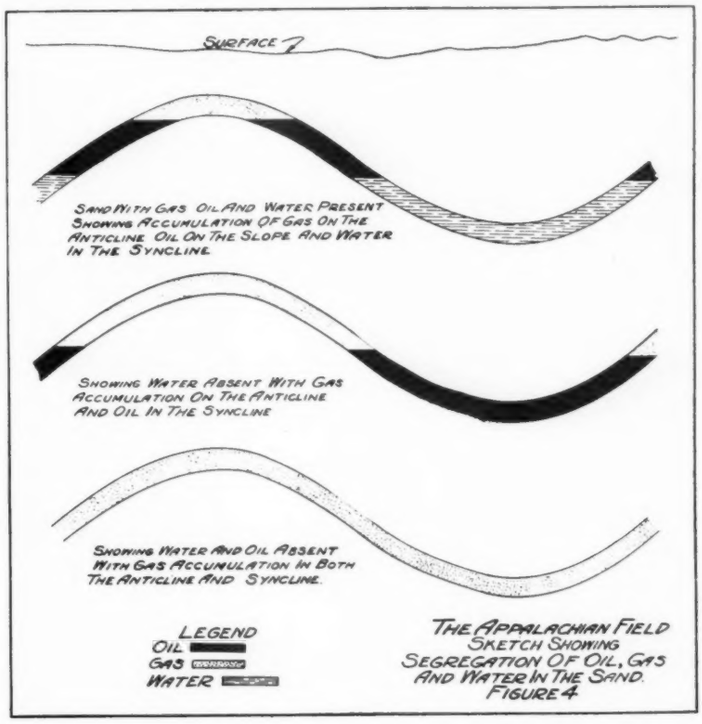
The production seems to be at any particular elevation of the Clinton sand, but resembles "shorelike" production. However, many pools are developed at about the same structural elevation as that of a pool either to the north or to the south.

Figure 7 represents the structure of the Burning Springs-Volcano-Eureka anticline, and shows the production to be on top of the anticline or dome. It will be noted that this structure is very steep, both to the east and west. Much water is found along the slopes. This is an exceptional type of structure for the Appalachian Field, but much oil has been produced along the axis of the Burning Springs-Volcano-Eureka anticline.

The foregoing Figures 5, 6 and 7 show typical forms of the structure which go to make up the Appalachian oil and gas field.

Figure 8 is an outline map of West Virginia, Pennsylvania, and a portion of Ohio, showing the location of longitudinal section, Kings Creek Station, W. Va., to McCance, Pa. Figure 9, also of cross sections A. A. Figure 10, Cross Section C. C. Figure 11, Cross Section D. D. Figure 12, and Cross Section B.B. Figure 13. Reference will be made to each of these later.

Figure 9 is a longitudinal section from Kings Creek Station, Hancock County, West Virginia to McCance, Westmoreland County, Pennsylvania. This is not a hypothetical section but is based on the average of actual well records. Looking at the extreme eastern portion of this section, it shows the location of the Peoples Natural Gas Co.'s deep wells, which will be referred to later. These wells are located on the Chestnut Ridge anticline, and start below the big lime or about the middle of the Big Injun sand. The thickness and depth of the various horizons encountered are drawn as nearly to scale as possible. Going westward the dip is rather pronounced until you reach the basin of the Latrobe syncline. In this syncline the Pittsburgh coal is below the surface, and has been extensively mined. Several wells have been drilled in this syncline and an abundant supply of salt water was the result. Extending farther west the Fayette anticline is reached, the Pittsburgh coal horizon being thrown many feet in the air with the Upper Freeport coal outcropping along the streams. Many good gas fields have been developed along this anticline. Going farther westward, the Grapeville anticline is encountered, upon which are many gas fields. Continuing westward the structure is quite regular but some of the sands thin out, and others disappear as shown by the sketch, while still others disappear and reappear. The Port Royal syncline is next reached where the Pittsburgh coal is below the surface. This district is generally known as the "Manor was on the extension of this Murrysville anticline that the famous McKeesport gas field was developed, in the fall of 1918. It is to be noted that a general Basin." Extending on westward the Murrysville anticline is encountered. The folds are getting less pronounced as we get away from the Allegheny front. A


SURFACE
SAND WITH GAS OIL AND WATER PRESENT SHOWING ACCUMULATION OF GAS ON THE ANTICLINE OIL ON THE SLOPE AND WATER IN THE SYNCLINE
SHOWING WATER ABSENT WITH GAS ACCUMULATION ON THE ANTICLINE AND OIL IN THE SYNCLINE
SHOWING WATER AND OIL ABSENT WITH GAS ACCUMULATION IN BOTH THE ANTICLINE AND SYNCLINE.
LEGEND
OIL
GAS
WATER
THE APPALACHIAN FIELD
SKETCH SHOWING
SEGREGATION OF OIL, GAS AND WATER IN THE SAND.
FIGURE 4

J. French Robinson

Oriskany		Silurian: Clinton Sand		Silurian: Lower or Gray Medina		Total Depth	Remarks
Top	Bottom	Top	Bottom	Top	Bottom		
....	....	2,260	2,320	2,470	2,493	3,572	Gas well
4,135	4,155	5,320	5,560	5,642	5,760	5,760	Dry hole
....	....	....	....	....	....	....	Drilled through Medina; dry hole
3,025	3,033	....	....	....	....	3,633	Dry hole
....	....	3,601	3,606	....	....	3,789	
....	....	....	....	....	....	3,250	Dry hole
6,045	6,315	....	....	....	....	7,248	Dry hole in deep sand
6,860	6,950	....	....	....	....	7,003	Dry hole in deep sand
6,807	7,185	....	....	....	....	7,756	Gas
....	....	2,075	2,088	....	....	2,088	
....	....	3,709	3,747	....	....	3,805	
4,499	4,595	....	....	....	....	4,597	Oil
....	....	....	....	....	....	5,267	Dry hole
....	....	....	....	....	....	5,250	Dry hole
4,312	....	....	....	....	....	4,900	Dry hole
3,980	4,060	....	....	....	....	4,250	Dry hole
7,018	7,037	....	....	....	....	7,579	Dry hole
....	....	....	....	....	....	7,386	Dry hole
....	....	4,600	....	....	....	5,000	
....	....	....	....	....	....	5,648	Dry hole
5,035	5,045	....	....	....	....	5,595	Dry hole
3,675	3,685	4,500	4,540	....	....	4,750	
....	....	....	....	....	....	3,170	Dry hole
2,750	2,760	....	....	....	....	2,770	Dry hole
....	....	....	....	....	....	5,575	Dry hole
5,476	....	....	....	....	....	....	Drilling at 6,000 feet, April, 1927
....	....	....	....	....	....	....	Drilling at 5,541 feet, April, 1927; well starts in Mauch Chunk
....	....	....	....	....	....	....	Fishing at 6,824 feet, April, 1927
....	....	....	....	....	....	....	Drilling at 7,000 feet
....	....	....	....	....	....	....	Drilling at 5,200 feet, April, 1927
4,060	4,085	....	....	....	....	4,400	Dry hole
....	....	....	....	....	....	4,949	Dry hole

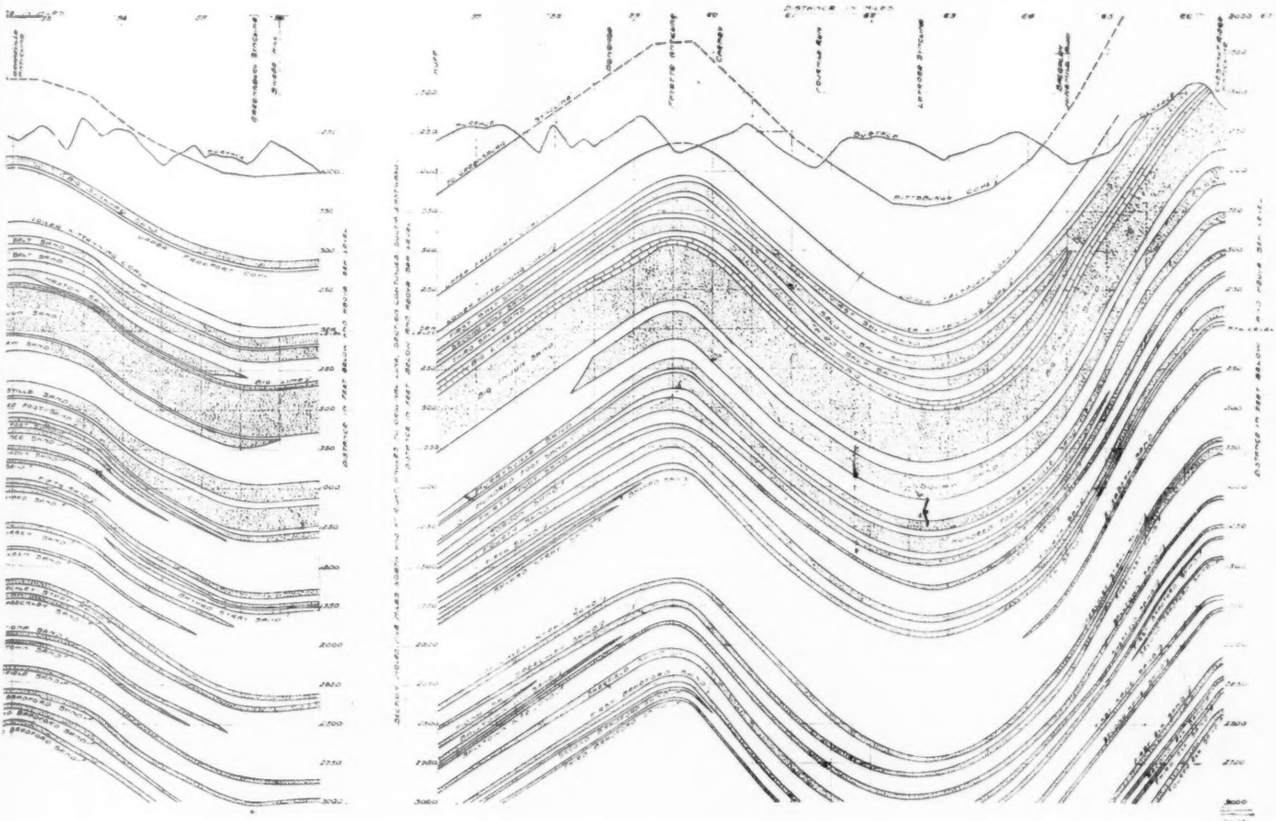


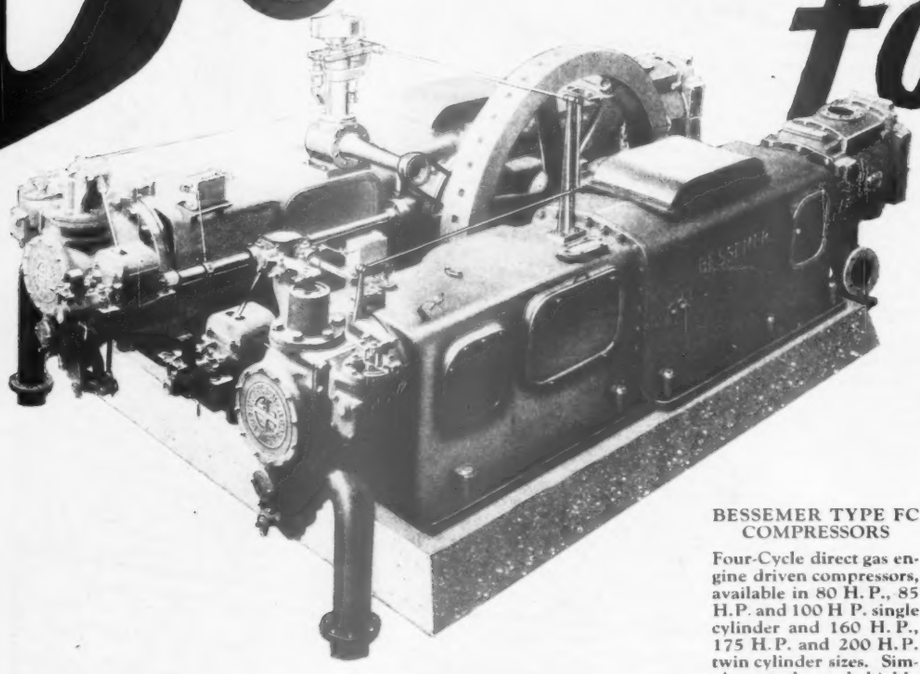
TABLE NO. 1—STRATIGRAPHIC COLUMN TOGETHER WITH COMPARISON OF HORIZONS THROUGHOUT THE APPALACHIAN FIELD

By J. French Robinson

System	Subsystem	Series	Formation	Name of Formation	Southwestern New York State Top	Southwestern New York State Bot'm	Clarion County Penna. Top	Clarion County Penna. Bot'm	Greene County Penna. Top	Greene County Penna. Bot'm	Barbour County W. Va. Top	Barbour County W. Va. Bot'm	Kanawha County W. Va. Top	Kanawha County W. Va. Bot'm	Cabell County W. Va. Top	Cabell County W. Va. Bot'm	Knott County Kentucky Top	Knott County Kentucky Bot'm	Eastern Ohio Top	Eastern Ohio Bot'm	Central Ohio Top	Central Ohio Bot'm	Tennessee Top	Tennessee Bot'm	Alabama Top	Alabama Bot'm
Carboniferous	Pennsylvania	Pittsburgh	Dunkard	Washington coal					520																	
				Waynesburg "B" coal					470																	
				Waynesburg "A" coal					438																	
			Monongahela	Upper Waynesburg coal					388																	
				Middle Waynesburg coal					339																	
				Lower Waynesburg coal					318																	
				Mapletown coal					90																	
				Redstone coal					60																	
				Pittsburgh coal					0		0				0				0							
			Conemaugh	Murphy sand					160	250	250	280														
				Ames limestone					260																	
				Little Dunkard sand					375	405	500								325	340						
				Bakerstown coal					405																	
				Brush Creek coal					485																	
				Big Dunkard sand					490	515	600	700							466	500						
			Allegheny	Upper Freeport coal					565																	
				Lower Freeport coal					810																	
				Upper Kittanning coal					885																	
				First gas sand					690	730	725	747														
				Middle Kittanning coal					730																	
				Lower Kittanning coal					775																	
				Vanport limestone			0	16																		
		Pottsville	Beaver River	First salt sand					850	920	1,050	1,150			1,145	1,280	0	210	675	775					Gas and oil production in Pottsville	
				Second salt sand					940	1,030	1,150	1,200					230	630	825	865						
				Third salt sand					1,070	1,110									915	965						
				Maxton sand					1,150	1,170	1,425	1,450	0	48	1,293	1,365	830	937	987	1,007						
	Mississippian	Mauch Chunk	Mauch Chunk	Little Lime					1,195	1,200	1,500	1,525	538	548	1,380	1,400	1,078	1,096								
				Pencil Cave					1,200	1,205	1,525	1,550	548	558	1,400	1,403	1,096	1,100								
			Burgoon	Big Lime					1,205	1,255	1,550	1,650	558	765	1,403	1,540	1,100	1,242	1,035	1,080						
				Keener sand																1,100	1,120					
				Big Injun sand			200	500	1,255	1,525	1,650	1,755	765	801	1,592	1,940	1,242	1,287	1,150	1,290						
		Pocono	Cuyahoga	Squaw sand			520	650	1,500	1,700	1,775															
				Weir sand							1,850		868	975			1,420	1,570								
			Berea	Second gas sand			700	740	1,740	1,800																
				Murrysville or Berea sand			800	830	1,840	1,880	1,925	1,965	1,197	1,209	2,123	2,140	1,840	1,865	1,670	1,745	9	23				
Devonian	Middle	Upper	Catskill	Gantz sand / Fifty-foot sand \ 100 feet					910	1,010	1,930 / 1,968	1,960 / 2,020	1,975 / 2,025	/ 2,038														
				Thirty-foot sand					1,030	1,060	2,035	2,070	2,125	2,175												
				Snee sand					1,090	1,110																
				Gordon stray sand					1,150	1,200	2,100	2,140	2,200	2,205												
				Gordon sand			0	20	1,300	1,320	2,175	2,195	2,275	2,285												
				Fourth sand					1,370	1,495	2,225	2,245	2,375	2,385												
				Fifth sand					1,430	1,450	2,290	2,320	2,475	2,510												
			Chemung	Bayard sand					1,550	1,570	2,390	2,400	2,550													
				Bayard stray sand							2,415	2,425														
				Bayard stray sand							2,435	2,450	2,625													
				Elizabeth sand					1,640	1,680	2,545	2,555														
				First Warren sand					1,890	1,900			2,800	2,816												
				Second Warren sand					1,950	1,965			3,000	3,015												
				Third Warren sand					2,030	2,050			3,200	3,220												
				Speechley stray					2,120	2,135	3,050	3,065														
				Speechley sand		750	777		2,190	2,230	3,120	3,135	3,500	3,530												
				Tiona sand					2,300	2,330																
				First Balltown sand					2,420	2,440			3,750	3,770												
				Second Balltown sand					2,500	2,540																
				Sheffield sand					2,570	2,600																
				Chipmunk sand		1,100	1,118																			
				First Bradford sand / Benson					2,680	2,720																
				Second Bradford sand / Group of		1,250	1,300		2,770	2,790			4,350	4,360												
				Third Bradford sand / W. Va.					2,855	2,870																
		Lower	Portage	First Kane sand					2,940	2,955																
				Second Kane sand					2,980	3,005			4,550	4,575												
				Third Kane sand					3,085	3,130																
				First Elk sand					3,420	3,450			4,750	4,780												
				Second Elk sand					3,465	3,500																
				Third Elk sand					3,520	3,585																
				White pebbly sand													2,300	2,400					Chattanooga shale			
				White pebbly sand													2,400	2,500					9			
			Oriskany	Corniferous lime		4,250	4,275		5,625	5,700					4,049	4,139			2,500	2,840						
				Oriskany sand					5,700	5,720					4,139	4,154	3,675	3,685								
Silurian	Cayuga and Ontario	Oneida and Salina		Salina group					6,050	6,300																
				Niagara limestone					6,570	6,700											880	1,580				
				Clinton sand		5,300	5,325		6,800	7,100											1,685	1,705				
				Medina sand		5,400	5,425		7,200	7,300					4,500	4,540	2,900	2,910								
Ordovician	Cincinnati	Oswego		Trenton limestone		7,200	7,960														3,000	3,663				
				Trenton sand																	3,663	3,863				
				Sevier shale																			500	1,030		
Cambrian	Saratogan	Potsdam		Potsdam		8,000	8,025																			

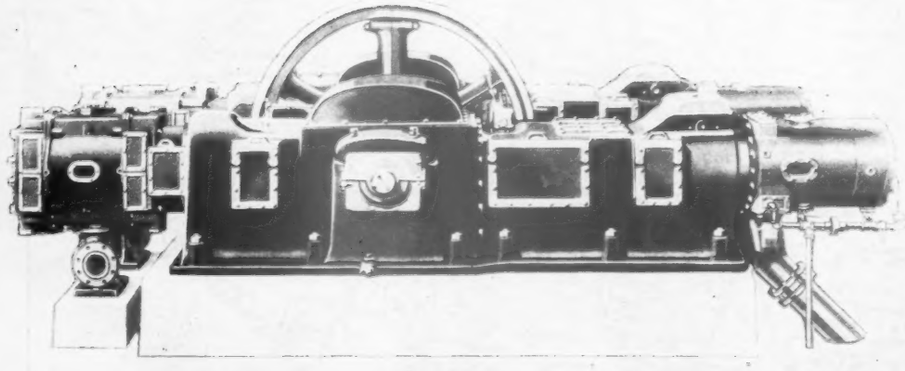
THE APPALACHIAN FIELD
SHOWING DISTRIBUTION OF
OIL AND GAS BY POOLS.
LEGEND: OIL GAS
OIL SHOW + LIGHT GAS ϕ
SCALE: APPROX. 50 MI.
FIGURE 1

Bessemer for



BESSEMER TYPE FC COMPRESSORS

Four-Cycle direct gas engine driven compressors, available in 80 H. P., 85 H.P. and 100 H P. single cylinder and 160 H. P., 175 H. P. and 200 H.P. twin cylinder sizes. Simple, sturdy and highly efficient units for all types of compressor service.

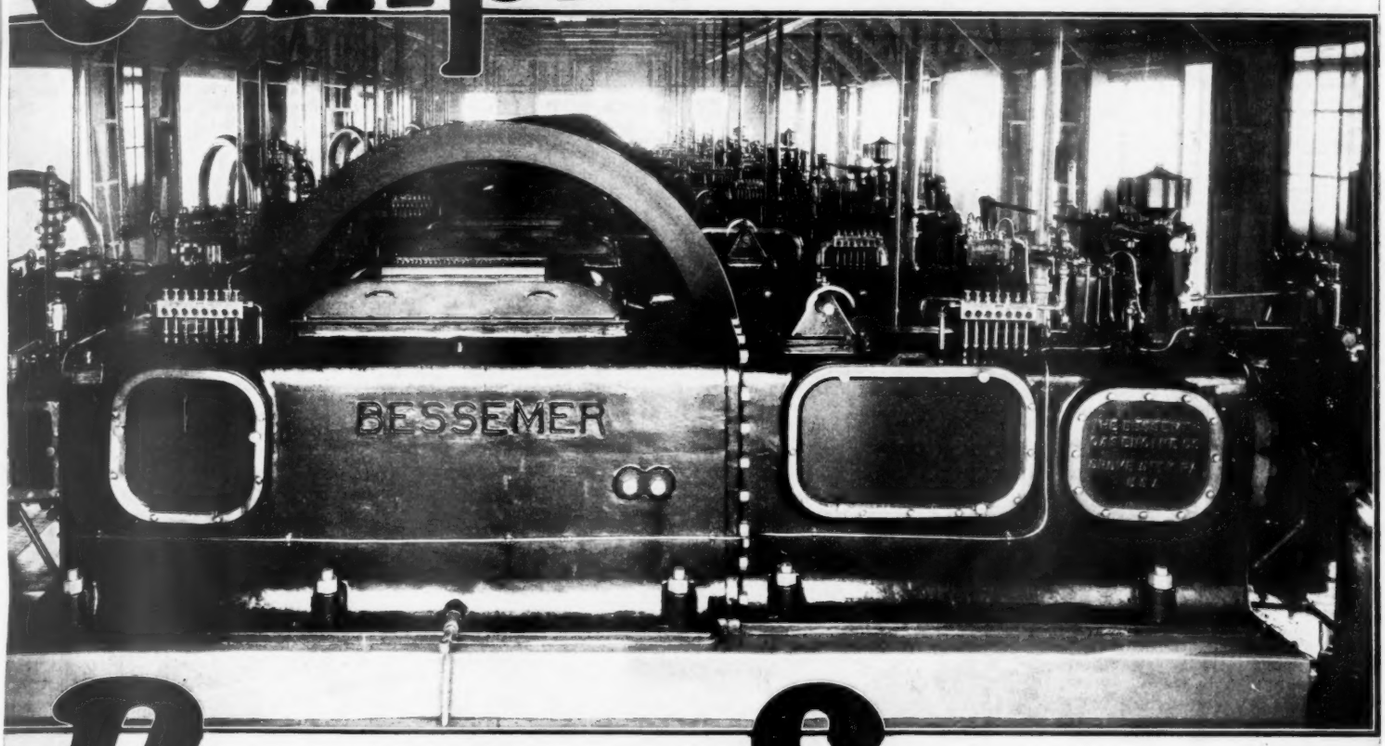


BESSEMER TYPE TEN COMPRESSORS

A Two-Cycle direct gas engine driven Compressor of unusual ruggedness, built to give long service with upkeep expense practically eliminated. All parts are easilly accessible and adjustable.

BESSEMER

Compressors



Booster Stations

THE PERFORMANCE of Bessemer Compressors is as outstanding on Booster Station work as it is on gasoline plant work and for flowing wells.

Their sturdy ruggedness assures years of dependable service. Their simplicity means fewer repairs and adjustments, their unequalled compression efficiency results in a lower cost per volume of gas handled, with less operating supervision and maintenance expense.

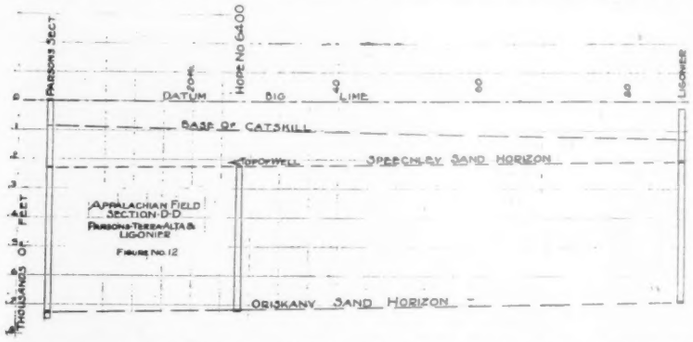
Bessemer Compressors consistently deliver 99% + running time on even the hardest compressor jobs and their performance records prove this statement.

THE BESSEMER GAS ENGINE COMPANY

52 York Street ∴ ∴ Grove City, Pa.

BESSEMER

thinning, both in interval and thickness of sand occurs as one goes westward. The Amity anticline shows less disturbance than those farther east. West of the Amity anticline sands begin to thin out and disappear very rapidly, and before we reach the Pennsylvania-West Virginia state line, nearly all of our deep sands up to the Hundred Foot sand have disappeared,—the Oriskany sand being encountered in one well only which was the Peoples Natural Gas Co.'s deep test well, No. 770, on the Geary farm near McDonald, Pa. The small insert in the lower left hand corner, and the line of longitudinal section on Figure 8, gives one an idea of the extent and scope of this section.



With but rare exceptions the subsurface structure coincides very nearly with the surface structure since in the Appalachian oil and gas field there are but few nonconformities. This is especially true in New York, West Virginia, Pennsylvania, and Ohio. Surface structure is used prior to development, but after production is obtained, subsurface structure is invariably used so as to get as near a true picture as possible of the horizons upon which one is working.

Faults play a small part in the production of oil and gas in the Appalachian Field as there are very few except in parts of Kentucky and Tennessee. Many faults occur in Northern Kentucky near the Warfield anticline.

Convergence of Beds

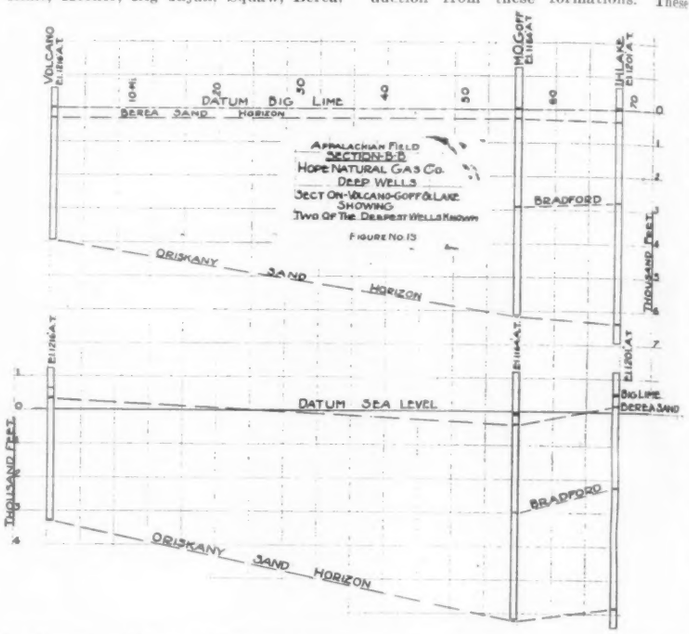
In studying the Appalachian geology, one must note the enormous thickening of certain horizons, especially going from central Ohio toward the southeast.

Figure 10, Section A-A (See Figure 8 for location) illustrates a section from Lancaster, Ohio to Altoona, Pa. showing the enormous thickening of the shales between the Berea sand horizons and the Oriskany and Clinton sand horizons. It will be noted that the McDonald well stopped only a short distance above the Clinton sand horizon. The Ligonier well which is much deeper did not reach the Clinton sand horizon by more than 1,000 feet. The thickening does not appear to extend south and north at such a rate as determined by a deep test of the Nixon Oil & Gas Co. on the Templeton farm, near Huntington in Cabell County, West Virginia on the south, and the Derrick City deep well on the north—See Table No. 2. Due to this enormous thickening to the east, many well records have been erroneously correlated and it is not uncommon to find wells abandoned before reaching a horizon which the operator thought he had reached at the time of abandonment.

Rocks

As previously stated the reservoir rocks are sands, shales, conglomerates or limestone, and for the most part are extended over a large area. In New York state the greater part of the oil is obtained from the Bradford sand, which is in the Chemung formation. Gas is produced from the Corniferous limestone of the Lower Devonian, from Guelph limestone, the Niagara limestone, and the Medina sandstone of the Silurian, from the Trenton of Ordovican, and from the Potsdam sandstone of the Cambrian. In Pennsylvania and West Virginia, oil and gas are obtained from many horizons, the chief of which are as follows: See Table No. 1 for correlation and intervals.) Uniontown sandstone, Mapletown coal, Pittsburgh coal, Murphy sand, Big Dunkard, First Gas sand, First Salt sand, Second Salt sand, Third Salt sand, Maxton sand, Big Lime, Keener, Big Injun, Squaw, Murrysville (Berea), Gantz, Fifty Foot, Thirty Foot, Snee, Gordon Stray, Gordon, Fourth, Fifth, Bayard group, First Warren, Second Warren, Speechley Stray, Speechley, Tiona, Balltown, Sheffield, First Bradford, Second Bradford, Third Bradford, Benson, Kane, Elk group.

The principal producing sands of Ohio are as follows: Mitchell, First Cow Run, Second Cow Run, Macksburg, Big Lime, Keener, Big Injun, Squaw, Berea, Corniferous and Niagara limestone, Clinton sand and Trenton limestone.



The principal oil and gas-producing horizons in Kentucky are as follows: First Salt, Second Salt, Maxton sand, Big Lime, Big Injun, Berea, Corniferous lime, Clinton sand and the Trenton limestone.

The production in Tennessee is mostly from the Fort Payne formation in the Mississippian. This formation consists of calcareous shale, fine sandstone, and some limestone, and imbedded chert. Underlying the Fort Payne formation is the Chattanooga shale of the Devonian Age, ranging from 35 to 45 feet in thickness. Some oil and gas is found in the Ordovician rocks in the Sevier shales. There are numerous anticlines in western Tennessee in the Palacioc rocks, but folds that enclose perennial rocks overlain by shale seem to be rare. Oil has been reported to occur in the Eocene rocks in the western part of the State, but the writer has no knowledge of any production from these formations. These rocks are similar in general character to some of the beds in the Salt Dome area of the Gulf Coast region.

The principal producing horizons in Alabama appear to belong entirely to the Pottsville formation, which consists of shale and includes limestone, sandstone beds and coal. The general structure of the Warrior Coal Basin, in

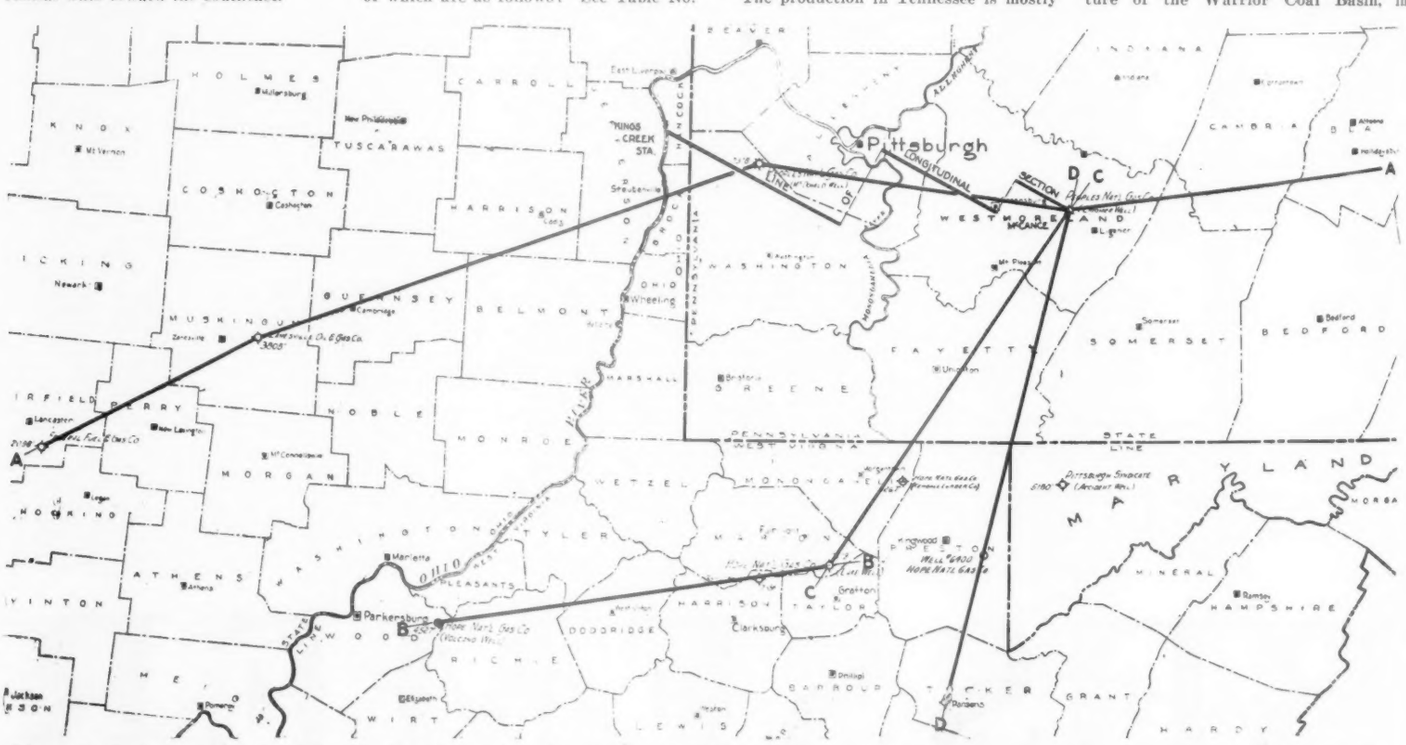
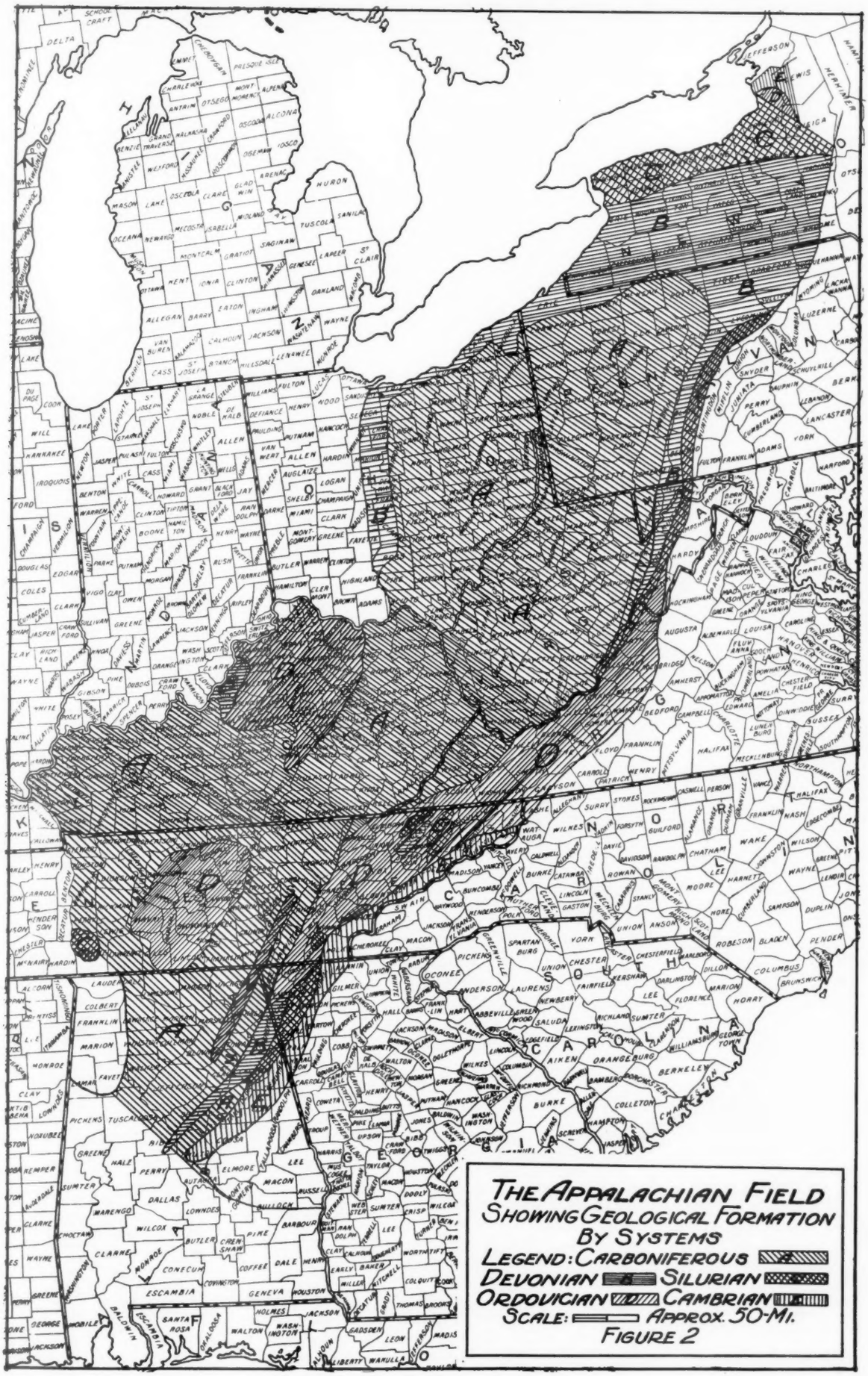


Figure 8—Outline map of Pennsylvania, West Virginia and a portion of Ohio, showing location of longitudinal section Kings Creek Station, W. Va., to McCance, Pa.—Sections A-A, B-B, C-C, and D-D.


THE APPALACHIAN FIELD
SHOWING GEOLOGICAL FORMATION
BY SYSTEMS
LEGEND: CARBONIFEROUS
DEVONIAN
SILURIAN
ORDOVICIAN
CAMBRIAN
SCALE: APPROX. 50-MI.
FIGURE 2

which the Fayette gas field lies, is that of a broad flat basin, gently dipped to the southwest. This field is about 50 miles west of Birmingham.

The Big Lime of Pennsylvania, West Virginia and Kentucky is perhaps a combination of the Greenbrier and Loyalhanna limestones of the Mauch Chunk of the Carboniferous system, while the Big Lime of Ohio is composed of the Corniferous lime and the Niagara lime and all that comes between. The Ohio Big Lime belongs to the Lower Devonian and the Upper Silurian. These two terms are sometimes confused. In western Ohio the Big lime referred to is the same as that of West Virginia and Pennsylvania, while in the central part of Ohio, the lime overlying the Clinton sand is spoken of as the "Big Lime."

The Big Injun sand of the Mississippian is perhaps the outstanding single sand in the Appalachian Field. It has a thickness varying from 50 to 400 feet. In many places it has two or more pays. It is the most prolific producer in the Appalachian Field.

The Murrysville or Berea, the Hundred-Foot sand, the Gordon and Fifth sands, have all produced large quantities of both oil and gas. (See Table No. 1 for Depths and Thicknesses.) The Berea sand is recognized over a very large area, especially in Pennsylvania, Ohio, West Virginia and Kentucky.

The Bayard group of sand in the Chemung formation, are lens-like, sometimes one, sometimes two, and quite often three lenses. They produce large quantities of gas for such thin sands. The thickness of these lenses seldom exceed 8 feet and very often less,—however, 6,000,000, 8,000,000 and 10,000,000-cubic foot gas wells are encountered in this sand.

The Speechley sand is composed of two sands, called "Speechley Stray" and "Speechley." The "Stray" comes about 50 feet above the true sand. Each have a thickness of about 40 feet. The "Speechley Stray" where productive, nearly always produces oil, while the true "Speechley" usually produces gas.

The Bradford sand has produced much oil in northern Pennsylvania and southern New York. It produces considerable gas in Pennsylvania.

The Clinton sand in the Silurian formation produces both oil and gas in Ohio. It has been reached by only one well (the Templeton, Cabell County, West Virginia), and was nonproductive.

The Trenton limestone is productive in Ohio, Kentucky and New York.

The composition of most of the reservoir rocks in the Appalachian Field is a well-cemented, fine-to-coarse grain siliceous or calcareous stone.

Porosity

The porosity of a sandstone or limestone will vary with a number of factors. Spherical grains of uniform size will afford the maximum pore space between grains. A sandstone or limestone composed of grains of many sizes, and of irregular shapes will be more compact,—the smaller grains filling in the interspaces between the larger. There has been very little work done in testing sands as to their porosity in the Appalachian Field, but is a factor worthy of considerable study. It has been stated that the sands of the Appalachian Field vary in porosity from 10 to 30 per cent.

Continuity of Sands

Referring to Table No. 1 and Figure No. 8, one gets an idea of the extent of a single sand over a vast area. This is especially true of the sands in Ohio, Pennsylvania, West Virginia and Kentucky—for instance, the Berea and Big Injun sands are found nearly everywhere. It is true that their character and thickness varies in different places, but the horizon actually exists. Some of the other horizons may lens in and out; while it is not the same continuous sand, it is one in nearly the same horizon, and is termed as one sand. In the extension of the Appalachian Field into eastern Ohio, the petroliferous stratum which are productive in western Pennsylvania, and West Virginia, are present. West of this belt is the Clinton sand field, which yields much oil and gas. Still further west and extending beyond into Indiana is the great "Lima-Indiana Field," in which oil and gas are derived from the Trenton limestone.

Migration

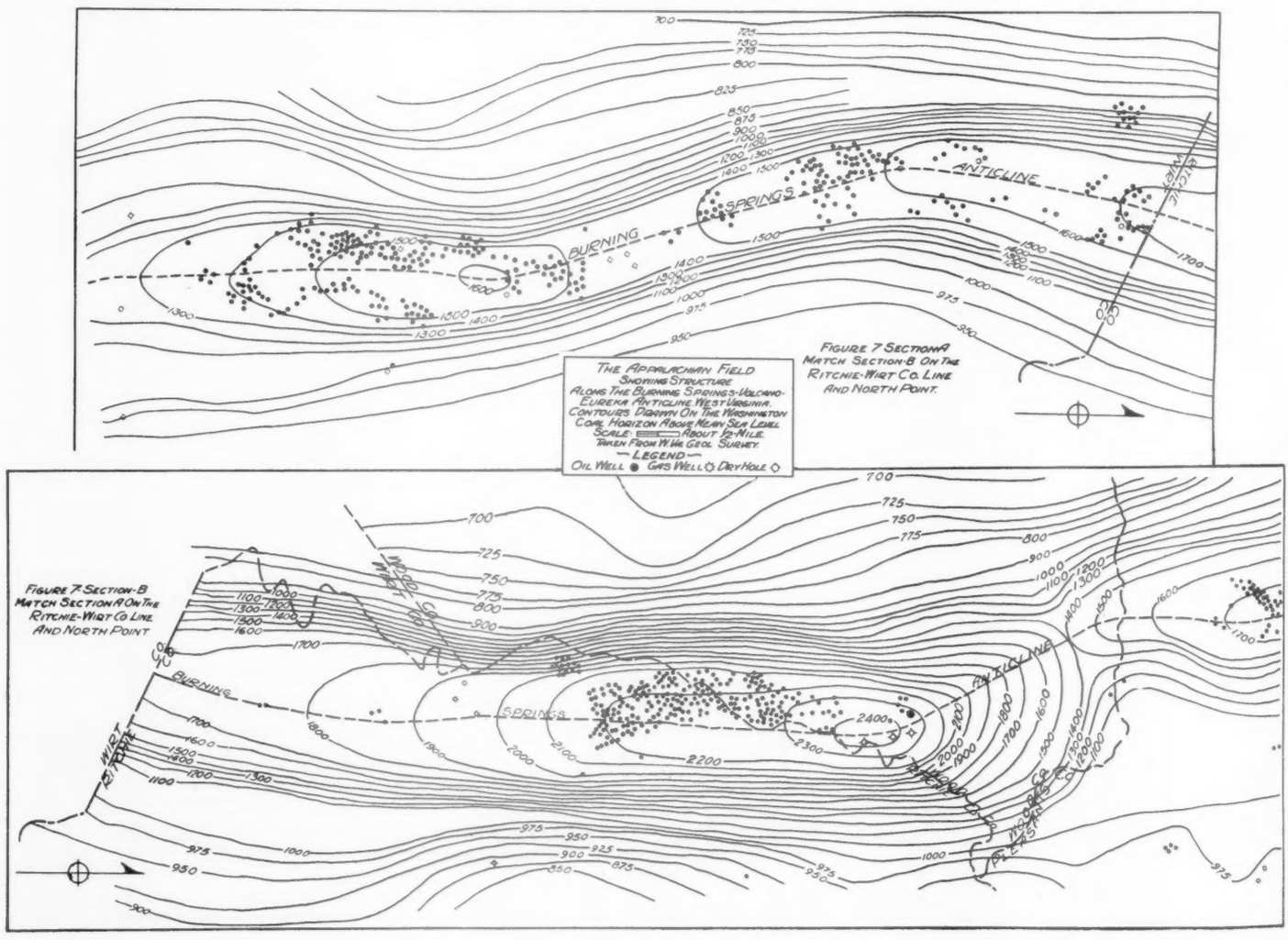
Most engineers and geologists have agreed that oil and gas is not limited to the formation in which same originated and were formed, but have migrated from the original bed where formed to their present places. It is the opinion of the writer, however, that after the oil and gas has migrated, possibly from the shales in which it was formed to the present place where it is "sealed in" in sandstone, limestones, etc., that there is no migration until the horizons have been tapped or broken. The migration was originally affected by gravitation, capillary attraction, and difference in specific gravity of the gas, oil and water. It is probable that the gravitation factor is very small and practically negligible on account of the friction which would be encountered through the rock. Capillary attraction is much more powerful than is gravitation, and is supposed to be an effective agent in the movement of oil. The principal factor in the movement and accumulation of oil appears to be in the specific gravity, or more accurately speaking, the difference in the specific gravities of water, oil and gas. Water has been such an important factor in the movement of oil that it has always pushed oil ahead of it when moving up a dip through porous stratum; consequently, after the rocks are saturated the oil has finally been accumulated on the highest portion of an anticline or dome. Where the saturated water has been removed subsequent to the time of structural change, the associated oil will still remain in a high position of the stratum since it does not move readily by the force of gravitation alone. In localities, however, the reservoir rocks were dry at the time of structural change, and are still dry, the oil may be found in the syncline. This is frequently true in West Virginia and some parts of Pennsylvania.

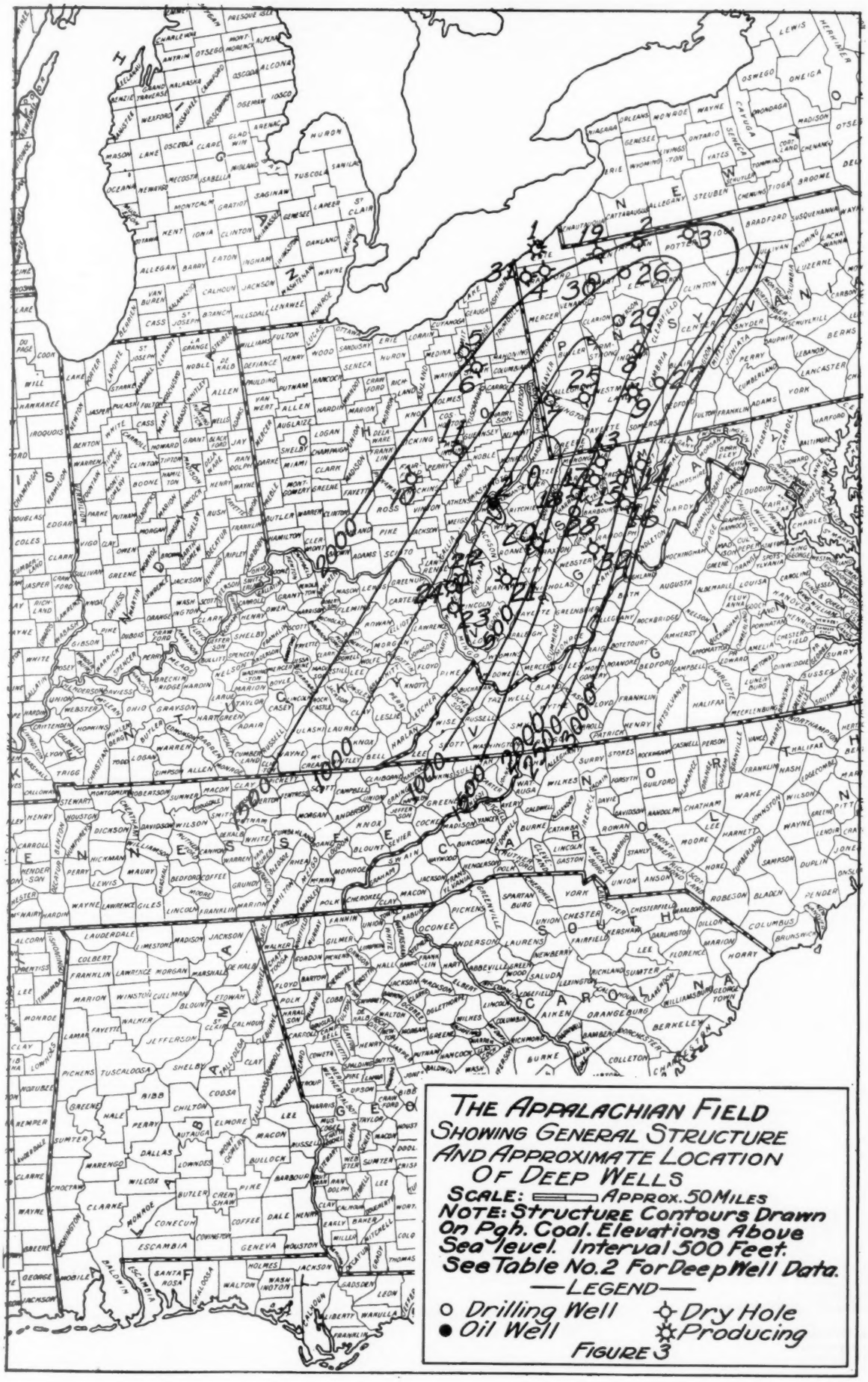
Deep Drilling

Considerable extraordinary deep drilling has been done in the Appalachian oil and gas field within the past few years. Figure No. 3 and Figure No. 8 shows the location of many of the deep holes drilled in this field.

Table No. 2 gives a summary of the deep drilling which has been done in the Appalachian Field, showing the location of the well and an idea as to where the well starts geologically, a few of the principal sands which were encountered, the total depth and the results obtained. From this information and referring to Figure No. 3 and Figure No. 8 a study of the advantages and disadvantages as to the various locations can be had. Many of these wells were drilled without geological advice, while others have been located scientifically. From a financial standpoint, deep drilling in the Appalachian Field has been a failure, but for geological information, it has been very successful. Figure 11, Section C-C shows a comparison between the Ligonier deep well, Pennsylvania, and the Lake deep well in West Virginia.

Figure No. 12, Section DD, shows a comparison between the Parsons, West Virginia, and the Ligonier, Pennsylvania, deep well, with the Terra Alta Hope


THE APPALACHIAN FIELD
SHOWING STRUCTURE
ALONG THE BURNING SPRINGS-VOLCANO-EUREKA ANTICLINE, WEST VIRGINIA.
CONTOURS DRAWN ON THE WASHINGTON COAL HORIZON ABOVE MEAN SEA LEVEL
SCALE: ABOUT 2-MILE.
TAKEN FROM W. VA. GEOL. SURVEY.
—LEGEND—
OIL WELL ● GAS WELL ☼ DRY HOLE ◇
FIGURE 7 SECTION A
MATCH SECTION B ON THE RITCHIE-WIRT CO. LINE AND NORTH POINT.
FIGURE 7 SECTION B
MATCH SECTION A ON THE RITCHIE-WIRT CO. LINE AND NORTH POINT
BURNING SPRINGS
ANTICLINE
WIRT CO.
RITCHIE CO.


THE APPALACHIAN FIELD
SHOWING GENERAL STRUCTURE
AND APPROXIMATE LOCATION
OF DEEP WELLS
SCALE: Approx. 50 Miles
NOTE: Structure Contours Drawn on Pgh. Coal. Elevations Above Sea level. Interval 500 Feet.
See Table No. 2 For Deep Well Data.
—LEGEND—
Drilling Well
Oil Well
Dry Hole
Producing
FIGURE 3

Natural Gas Co. deep well No. 6,400 between. See Figure No. 8 for location.

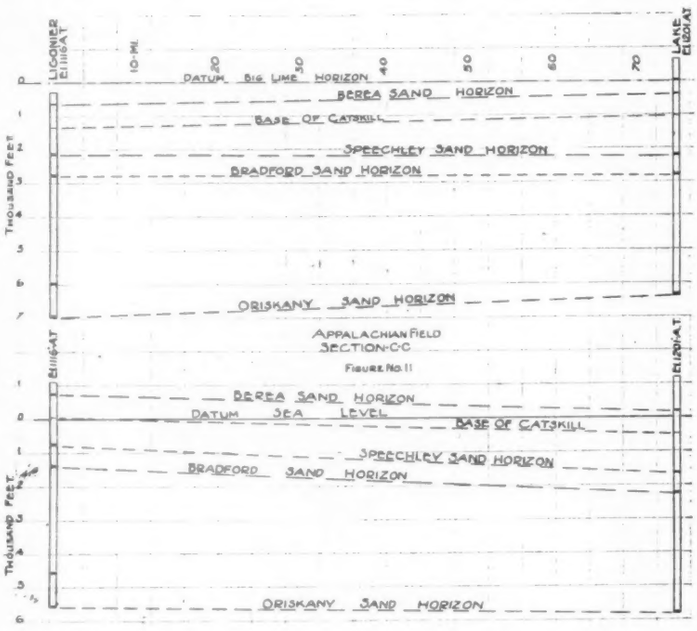
Figure No. 13, Section BB, shows the relation between the Volcano, West Virginia deep well, M. O. Goff, and I. H. Lake deep wells in West Virginia. See Figure No. 8 for location. A well was drilled near Central City, Cabell County, West Virginia, and found what is believed to be the Oriskany sand at 2,750 to 2,760 feet, and stopped at what is probably the Helderberg limestone at 2,770 feet. Another well drilled at Paddle, Wayne County, West Virginia, reached the Helderberg limestone at 2,760 feet to 3,170 feet, but found no Oriskany sandstone. Still another well on Slaughter Creek, Kanawha County, West Virginia, found the Oriskany sandstone at 5,035 to 5,050 feet and stopped at 5,095 feet in the Helderberg limestone. The well at Parsons, Tucker County, West Virginia, found the Oriskany sandstone at 3,980 to 4,060 feet and stopped in shale at 4,250 feet. The M. O. Goff well at Bridgeport, Harrison County, topped in the Corniferous lime at 7,386 feet, probably a few feet short of the Oriskany sand. The I. H. Lake well, 7 miles southeast of Fairmont, Marion County, West Virginia, found the Oriskany sand at 7,018 feet to 7,058 feet, and stopped in the Helderberg limestone at 7,579 feet, which was for many years the deepest well in the world, but failed to reach the long-searched-for Clinton sand by several hundred feet. Near Volcano, Wood County, West Virginia, three holes were drilled, (See Figure 7, Section B), one of which found oil in the Oriskany sand, the other two were failures. In Pennsylvania several deep holes have been completed; three of which are at McCance, Westmoreland County, Pennsylvania. The first one, Booth & Flinn No. 1, the Peoples Natural Gas Co.'s well, No. 1,588, obtained gas from the Oriskany sand at a depth of 6,822 feet. The second well, Seger Brothers, the Peoples Natural Gas Co.'s well No. 1,699, was abandoned at a depth of 6,989 feet. The third well, Booth & Flinn No. 2, the Peoples Natural Gas Co.'s well, No. 1,842, obtained gas from the Oriskany sand and the Coeymans sand at 7,185 feet to 7,428 feet. The total depth was 7,756 feet. This well held the record as the deepest well for sometime, but has since taken second place, giving way to a well in California. With the exception of one of the Volcano wells and the two wells near Ligonier, practically all of the deep wells in this vicinity have been failures as far as production is concerned. Many wells have been drilled through the Clinton sand in central and eastern Ohio, and have not been listed as "deep wells," although some of them have passed through the Trenton limestone. Several wells have also been drilled through the Trenton limestone in New York but are not listed as "deep wells" due to the shallow depths at which these horizons were encountered. Temperature tests have been taken in several of the deep wells drilled in the Appalachian Field and the following Table No. 3 will summarize these results. It will be noted that the temperature increases with depth at the rate of 15 degrees per 100 feet.

The results of temperature tests also show that the higher temperatures are found at the highest places on the structure. Structurally speaking, the Hope Natural Gas Co.'s well No. 6,400 at Terra Alta, West Va., starts lower than any other of the deep wells on which we have temperature tests—that is—the structure is higher; hence, the temperature at 4,000 feet is nearly 10 degrees higher than that of any of the other wells for the same depth.

Due to the steep slopes of many of the structures in the Appalachian Field and comparatively narrow apexes, many of the deep wells have been troubled with slanting holes. Considering the slope which some of these wells had, and the drill progressing, seems impossible. One well was actually drilling when the hole was off the true vertical as much as 50 feet to the 100 feet. These deflections varied from a few feet per 100 feet to 50 feet per 100. The deflections were determined by the use of hydroflouric acid etching a bottle and the use of simple trigonometry in making the calculations.

Value of Well Log

The value of well records for geological work in determining subsurface structure, must not be underestimated. By far too little attention is paid to well records. Many thousands of dollars are annually lost through not knowing the location of water and gas shows, which were evident at the time the bit passed through them. Some uniform system of keeping logs should be in vogue. Every operator should keep a close and accurate report of the formation through which the well or wells are drilled. A steel line measurement should be taken to all beds penetrated and the principal sands and limestone horizons. A driller throughout the Appalachian Field has not only performed his own duty, but has been left to do the duty of a geologist in the correlation of sands. Throughout a large portion of the territory, his correlation has been good, considering the information which he had. However, many wells are recorded as producing from a sand horizon, which in fact was not penetrated. This is true of many wells which were reported as "dry" in the sand horizons not reached. This is largely due to the thickening and thinning of the interval of different sand horizons.



Oil Recovery

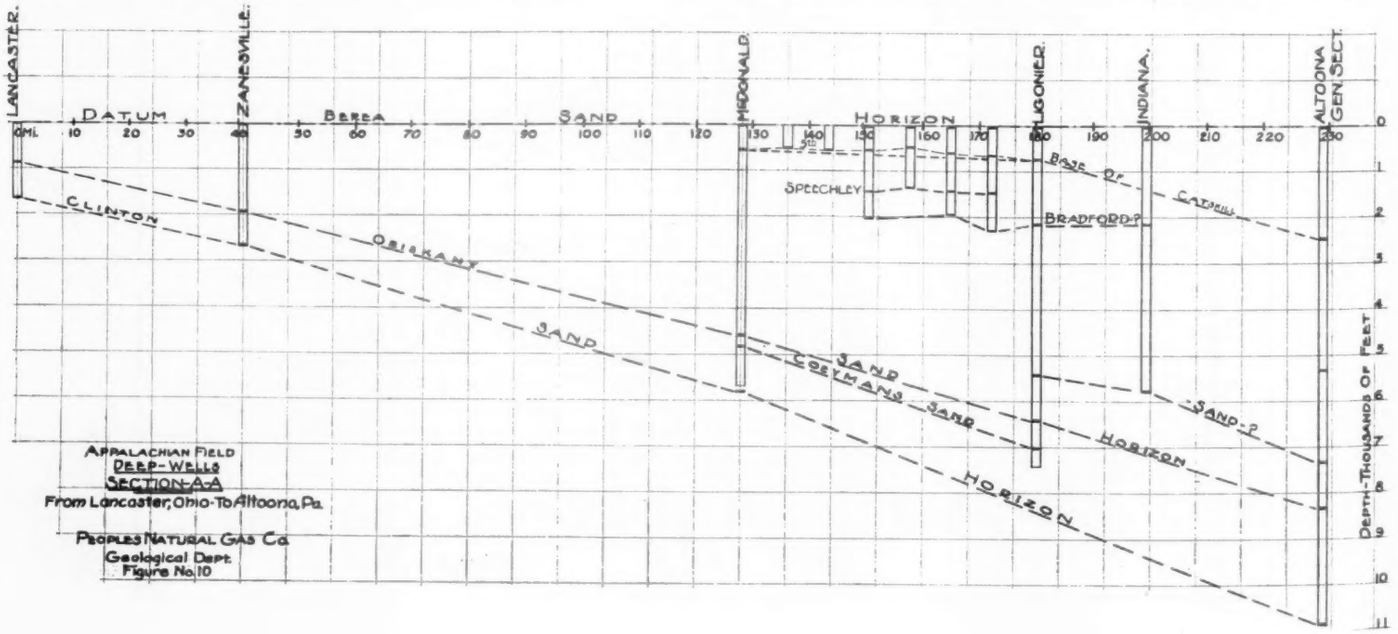
Reviving old oil fields by means of water, air or gas pressure is attracting considerable attention at the present time in the Appalachian oil and gas field. The Bradford oil field has been under water flooding for sometime, and good results have been obtained. Air and gas are being pumped into the oil sand under pressure varying from a few pounds to several hundred pounds and by this method the production of old fields has been increased from 400 per cent to 3,600 per cent. It is the writer's opinion that the structural conditions again are one of the principal factors in determining the inlet or pressure wells; therefor, in order to apply pressure, it is necessary to have a detailed structure map available. Each sand is a problem within itself as it is necessary to keep sufficient pressure so as to force the fluid ahead of it, and again not to apply too much pressure that it will by-pass your fluid and thereby not do the work desired.

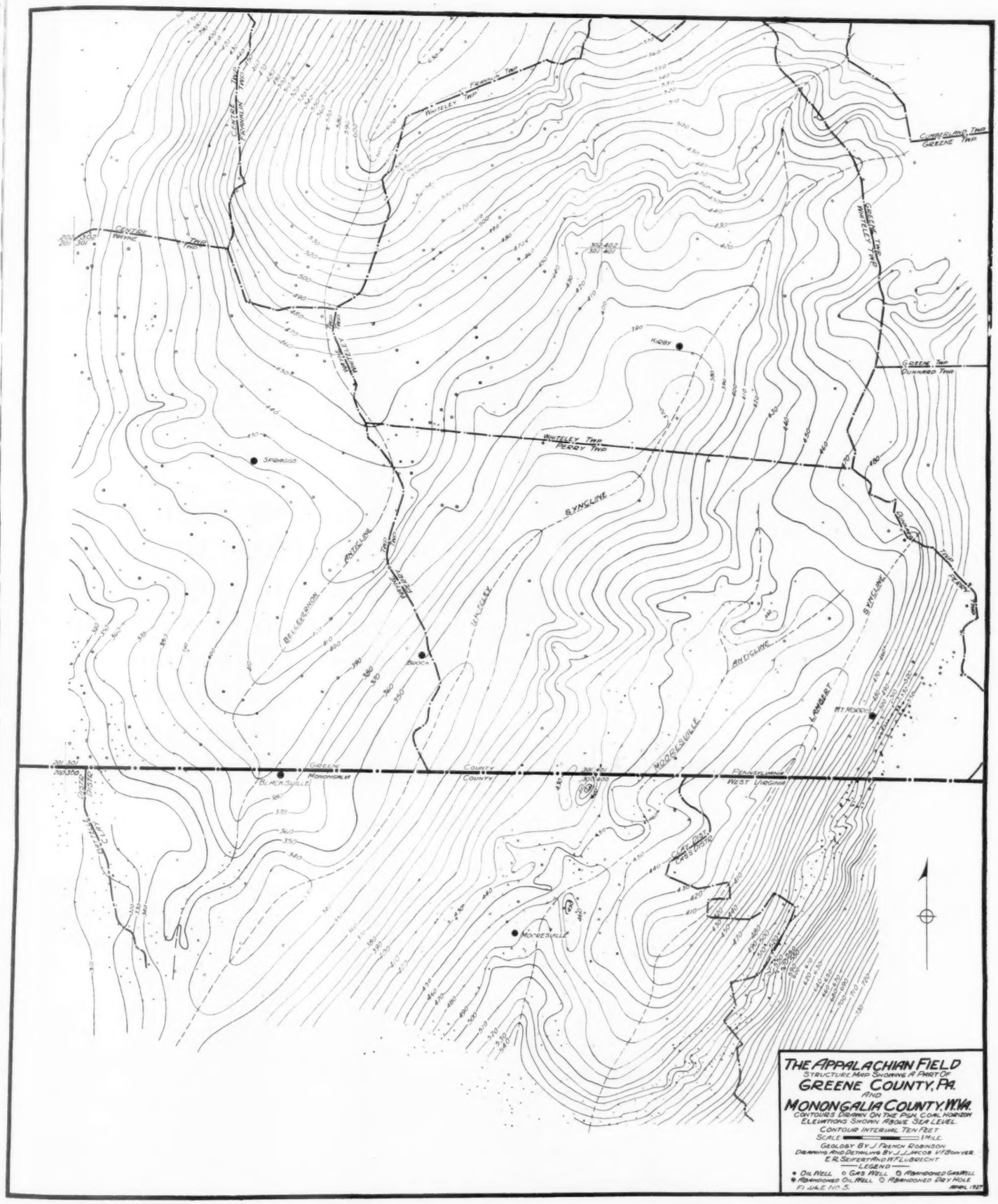
It is generally believed by the majority of oil technologists and geological engineers that from 20 per cent to 40 per cent of the original amount of oil in the oil sand can be extracted by the present flowing and pumping methods. There is, however, much diversity of opinion on this question, especially, among practical oil men. It must be conceded, however, that a large percentage of oil remains in the sand after the wells have been completely exhausted by pumping in oil fields where the productive horizons consist of sands or sandstones, or where the pore spaces are small.

Future Outlook

The outlook for oil and gas production in the Appalachian Field is very little changed from the past few years. It is gradually decreasing each year, notwithstanding the fact that small pools and fields are developed, which at the time looks as though it might affect the total production, but these are of such short life that they do not materially change matters except to retard the decline temporarily. The Cambridge Gas Field which is producing from lenses in the Corniferous or Niagara lime is one of the most recent gas and oil developments. Some of these wells have an initial volume of about 25,000,000 cubic feet per day, others are showing for good oil wells.

The oil wells in the Appalachian Field will average less than a barrel production of oil per day and the gas wells will




THE APPALACHIAN FIELD
STRUCTURE MAP SHOWING A PART OF
GREENE COUNTY, PA.
AND
MONONGALIA COUNTY, W.VA.
CONTOURS DRAWN ON THE PGH. COAL HORIZON
ELEVATIONS SHOWN ABOVE SEA LEVEL
CONTOUR INTERVAL TEN FEET
SCALE 1 MILE
GEOLOGY BY J. FRENCH ROBINSON
DRAWING AND DETAILING BY J. J. LARCOR V. T. BONYER
E. R. SEIFERT AND W. F. LUBRECHT
LEGEND
OIL WELL GAS WELL ABANDONED GAS WELL
ABANDONED OIL WELL ABANDONED DRY HOLE
PLATE NO. 5.
APRIL 1927
WHITELEY TWP
FERRY TWP
GREENE TWP
DUNKARD TWP
CUMBERLAND TWP
GREENE TWP
CENTER TWP
WAYNE TWP
FRANKLIN TWP
MORGANTOWN
BLACKSVILLE
MOORESVILLE
SPRAGGS
BOOCH
MT. MORRIS
SYNCLINE
ANTICLINE
COUNTY
PENNSYLVANIA
WEST VIRGINIA

Since 1880 FISHER in the field

From this humble, small plant in 1880—The Fisher Governor Company has in the past 47 years grown to this—one of the largest and most modern plants devoted to the manufacture of regulating equipment for the oil, gas and steam industries.

FISHER
TRADE MARK
REGISTERED

GAS PRESSURE REGULATORS

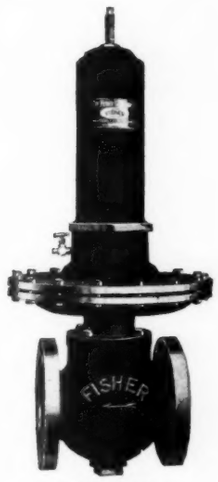
Vacuum Regulators

For the control of vacuums under all conditions, there is a Fisher type to meet your requirements.

Regulating gas from field to compressors . . . holding atmospheric pressure on batteries of tanks . . . are two of the commonest uses. Hundreds of these regulators are in daily use, operating without trouble and delivering consistent service.

We are showing here a cut of the Type 87, which is a casing head self-enclosed combination Back Pressure and Vacuum Regulator, which is especially useful in eliminating friction caused by dirt, sand, snow or sleet.

Type 86 is an ultra-sensitive, all metal self-enclosed vacuum Regulator; will hold positive line down to ½" of mercury on inlet side, while Type 88 will regulate any vacuum on inlet side or if desired can carry 3 lbs. pressure on inlet side and vacuum on outlet.

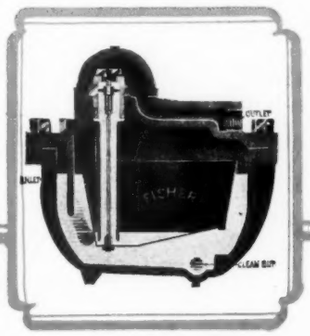


TYPE 87
Back Pressure and Vacuum Regulator

Gasoline and Gas Water Traps

Where gasoline is manufactured under pressure and also for taking gasoline out of gas lines it is necessary to use a trap. Experience has taught engineers and operators in this field, that the only type of trap that can be used is the intermittent type open bucket trap. It is essential that a trap of this kind be so designed that the vapor loss is reduced to the minimum. In numerous tests the FISHER trap Type 333 has proven its efficiency in this particular. The shape allows the use of an aluminum bucket of large area, which in turn permits the use of a valve seat with an extra large orifice; this in connection with the specially designed valve seat reduces the liability of freezing.

We also manufacture a trap, Type 3333, for removing water from gas mains. This trap is constructed the same as the gasoline trap with the exception of the metal used in the bucket.



The Fisher Trap, Type 333, is so designed that the vapor loss is reduced to the minimum.

THE FISHER GOVERNOR CO.

395 FISHER BLDG.
MARSHALLTOWN, IOWA, U. S. A.

TYPE 211

FISHER
TRADE MARK
REGISTERED

TYPE 211

This specialty is built to handle reduced pressures of from 5 lbs. up to 80% of the initial pressure. It is suitable for hot or cold natural or artificial gas, hot or cold air, or other gaseous fluids.

TYPE 210

Type 210 is generally used for reducing the gas pressure in distribution mains, reinforcing lines, or service mains. As a low pressure regulator on such service it will maintain a gas pressure of a few ounces regardless of normal pressure pulsations on the inlet side of regulator. This type is simple in design, has few working parts, and is ruggedly built for severe service.

TYPE 210

hardly average 20,000 cubic feet of gas per day.

Acknowledgement is hereby made for references to the various state publications, United States Geological Survey Publication, and many text books from which the writer has obtained thought and suggestions for this article.

Thanks are due Dr. Charles E. Fettke for his criticisms and suggestions on this paper, and to B. F. Hoffaker, geologist, Pittsburgh, for elevations in Greene County, Pennsylvania, and to Messrs. Jacob, Benkert, Bowyer, Seifert, Wiant, and Miss Knoll, who assisted the writer in making drawings, details and typing.

Metering Gas Went Against the Grain In Paola, Kansas

"The Western Spirit," a newspaper of Paola, Kans., edited by B. J. Sheridan, recently had a very interesting article under the heading "How People Change," showing the trouble the gas company had in placing meters in the city of Paola in the early days.

The following is Mr. Sheridan's article:

"When natural gas was brought to Paola, 40 years ago, it was sold at so much a month per stove,—a coal or wood range, $1.25 a month; heating stove, $1.50 to $1.75 per month and lights, 15 to 25 cents each, per month. Those using gas let it run all the time, throwing doors and windows open when rooms got too warm.

"I advocated that such a waste would bring want, and all gas should be sold by measure—metered. People didn't take to it, and hundreds stopped The Western Spirit, claiming that it had been subsidized by the gas company. When W. M. Mills shipped in a car load of gas meters, to be used, it was only by the firmness and shrewd management on the part of the sheriff and city marshal, that a mob was prevented from capturing the meters, and throwing them into Bull Creek.

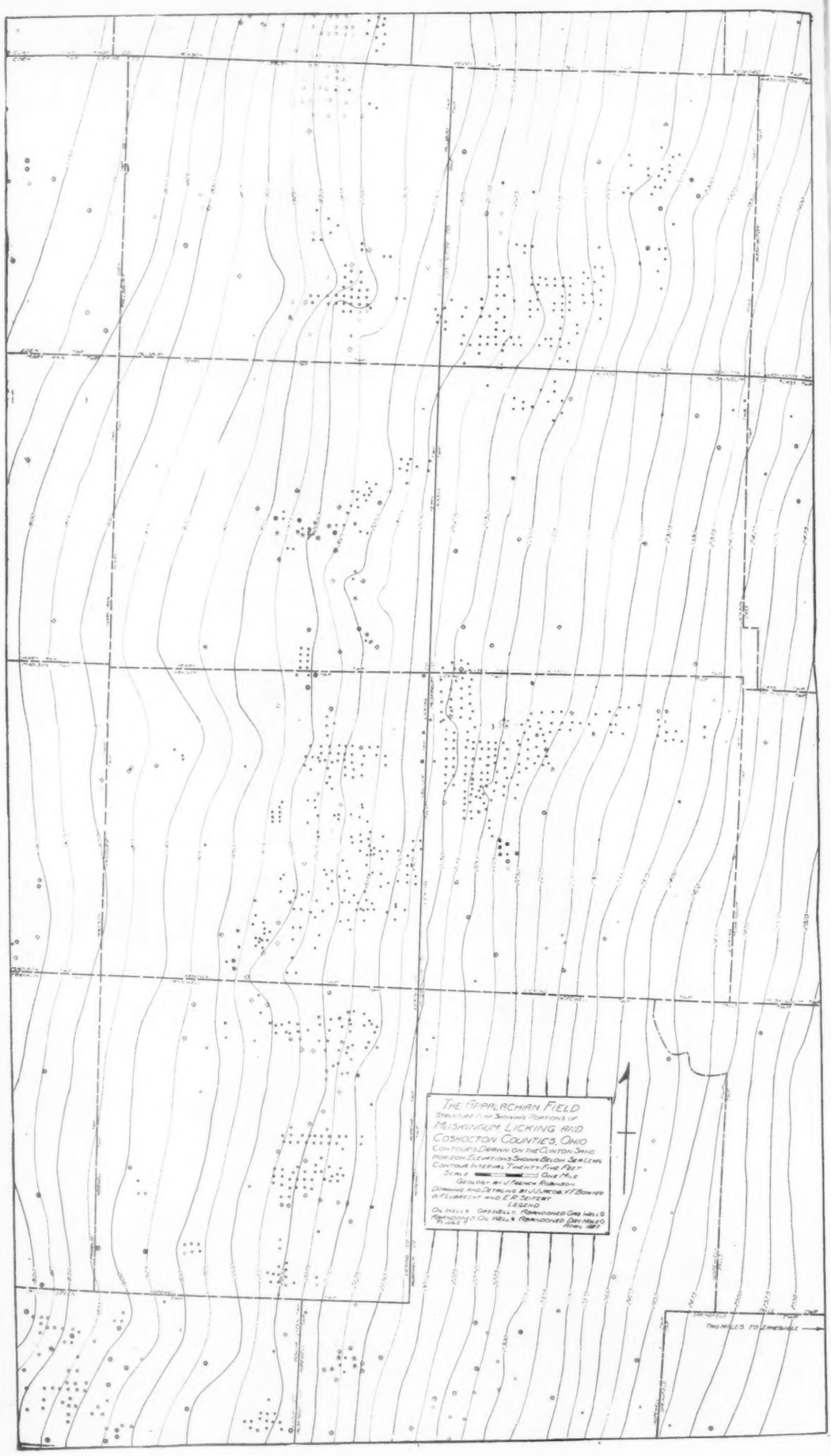
"Finally, when W. M. Mills was repairing his lines, and setting meters, the city authorities, urged on by angry patrons, had the workers arrested. When excitement was at its height, W. M. Mills turned the gas off and it was in the dark of the moon, at that! Such excitement was never before known. Meters were destroyed, and laterals torn out. The few wood yards left were invaded, and the supplies carried off. It was medium fall weather, and hundreds of families cooked in the streets. Bonfires blazed intermittently all over town. The gas was off for 16 hours, and, by a sort of compromise, was turned on again.

"This was the turning point on the metering of gas. A few still kicked, some going back to wood or coal, but the flat rate ended for good. But the fight against the gas company continued—and a little of it shows up in every municipal election.

"From 1880 to 1895, highways, east of Paola, from the Boone land by the East Wee Creek bridge, to the "Tar Spring," in Middle Creek Township, were lighted by gas torches, some 20 feet high, that burned night and day. H. H. Grimshaw had two flaming beacons on top of the Commercial Hotel, and gas flickered all night, right along, from barrels of water, into which gas was piped at the bottoms of the barrels.

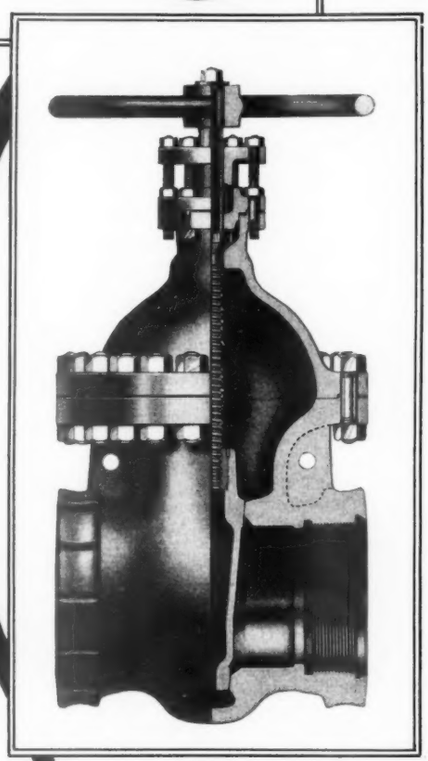
"The meter rate started in at 20 cents per 1,000 cubic feet and now it is 65 cents! But Paola and many other gas-producing places in this country, went some in those early days on the use of gas. The belief was general that gas wells, like water wells, would fill up when the supply was taken out.

"Many men and women actually advocated, for several years, that natural gas, like air and water, should be free. How people change!"


THE APPALACHIAN FIELD
STRUCTURE MAP SHOWING PORTIONS OF
MUSKINGUM, LICKING, AND
COSHOCTON COUNTIES, OHIO
CONTOURS DRAWN ON THE CLINTON SAND
HORIZON ELEVATIONS SHOWN BELOW SEA LEVEL
CONTOUR INTERVAL TWENTY-FIVE FEET
SCALE ONE MILE
GEOLOGY BY J. T. FRENCH AND HOUGH
DRAWING AND DETAILING BY J. N. JACOB, V. F. BOWYER
A. FLUBRECHT AND E. R. SEIFERT
LEGEND
OIL WELLS GAS WELLS ABANDONED GAS WELLS
ABANDONED OIL WELLS ABANDONED DRY HOLES
TWO MILES TO ZANESVILLE

Natural gas demands *good* valves

CHAPMAN Iron Body Valves especially designed for use on natural gas lines. Made in sizes from 2 in. to 16 in. and for pressures up to 1200 lbs.



CHAPMAN Chrome Nickel Steel Drilling Valves, solid Wedge or Double Disc, made in all required sizes and for pressures up to 2000 lbs.

The terrific gas pressures developed at the well head can be controlled by only the best equipment. To a large number of operators, this means CHAPMAN Valves.

The very nature of gas makes a little leak a serious thing in valve or pipe line. Again, only the best is good enough—and again, operators specify CHAPMAN Valves for this profit-guarding service.

Wells, pipe lines, booster stations, distributing lines—all need good valves—CHAPMAN Valves.

Kept in stock for immediate delivery at strategic points in all fields.

The Chapman Valve Manufacturing Co.
Indian Orchard, Mass.

Branch Offices:

New York	Detroit	Pittsburgh
Boston	Houston	Philadelphia
Chicago	Atlanta	San Francisco
Cleveland	Tulsa	Los Angeles
	Syracuse	

Distributors:

E. L. Wilson Hardware Co., Beaumont and Houston.
Wagner Supply Co., Dallas

Chapman Valves

Service Charge and What It Represents

Helps Pay Operating Costs and Is Equitable. Sliding Scales Upward and Downward Are Explained

By W. G. Rogers
The East Ohio Gas Co., Cleveland, Ohio

Until a comparatively recent date, natural gas had been produced very cheaply and in very large volumes. As the available supply greatly exceeded the possible markets, it was sold to domestic consumers at a very low rate to insure a large volume of house heating business. Industrial rates were low enough that coal could be displaced on a competitive price basis for nearly every purpose for which it was used. The organization of a natural gas company was not a very large one and very little attention was given to the matter of rates so long as they showed an adequate net each year. It is very probable that few, if any, companies knew whether their domestic business as a whole was on a profitable basis or not—let alone the equity of the rate as among consumers.

It was very unfortunate that during the period of rapidly rising prices the older fields in the Appalachian district were becoming exhausted and in the newer ones the supply was not nearly so prolific as the older ones, in addition to being farther from the market. This, coupled with the tremendous increase in the cost of drilling, brought the price of gas to a point where the distributing companies were compelled to give their rate problems immediate and serious consideration.

Higher Rates Necessary

The extremely low industrial rates had to be discontinued immediately and all other rates radically increased. The cancellation of the low rate to industrial consumers was followed by a loss of a large part of this business as the increase in coal prices was not sufficient to leave natural gas in the competitive field.

The companies were now compelled to turn to their domestic consumer for the principal source of their income. Upon serious consideration of this problem, a few companies found that they were making a small profit on this class of consumers, some discovered they were only breaking even with them and not a few, upon close examination, discovered they were actually serving their domestic consumers at a loss and were making up this loss, together with all their profits, from a large volume of industrial business now no longer available on account of competitive fuels.

A careful analysis of the situation indicated that approximately 75 per cent of their customers were served at an actual loss even when the rates had been increased sufficiently to return to them all of their operating expenses as well as a reasonable return on their property. The rate, however, was so high that the profitable consumers were fast turning to competitive fuels and curtailing their use of gas to a marked degree. As a matter of checking this tendency which would eventually place the industry in a dangerous position, the service charge was looked upon as a means of removing some of this unfair burden from this small group of profitable consumers and placing it upon the great number of heretofore unprofitable ones where it rightfully belonged.

Helps Pay Operating Cost

So much has been written on the service charge that not much time need be taken here in arguing its case. Up to the present time, absolutely no argument has been advanced against it, other than its unpopularity with the public, and this is a matter of presenting the facts to the public. So far it is the only practical element of a rate structures that has been devised that will provide a means for a natural gas company of deriving from 65 to 85 per cent of its consumers who had been previously served at a loss, an amount of revenue that will even approximate a fair share of the operating costs and capital charges which are incurred for the direct benefit of those consumers.

It is not our purpose to present a formula for popularizing the service charge. The general attitude of the public is too well known to try anything of that nature but we do think that any company that fears to put a service charge in effect or abandon one already in operation (and there have been such cases) has not only neglected a duty to itself but to its consumers as well. The mere fact that there are at least 50 court and commission decisions favoring it and to our knowledge not a single one condemning the service charge as such, is the greatest argument as to its fairness.

Experience has taught us that every company must follow a few well charted steps in selling this rate to the customers and the public at large. First, and I cannot put too much emphasis on this point, it must be sold to the company employes. Better than newspaper advertisements and talks to civic organizations, and I am not underestimating the value of this work, is the first-hand information that a customer gets from the application or complaint clerk. If the company itself (this means all of the employes as well as the management) is not entirely sold on it, then it is useless to try to sell it to the public.

Workers Good Consumers

The old objection of the political authorities, from whence it filtered to the public, was that it placed an undue burden on the small consumer. They naturally assumed, without giving the matter sufficient thought, that the service charge places a greater burden on the small consumer than the flat rate did—and this is readily admitted, for under that form of rate the small consumer was carried by his next door neighbor, regardless of whether he lived in the neighborhood of the laborer or in the neighborhood of the well-to-do.

Investigation by many companies in cities of all sizes have always led to the same result—the laborer is not the small consumer in any sense of the word.

Not an Additional Charge

It is especially important that the consumer should know that a service charge is not an additional charge superimposed upon his regular rate for gas but that the costs and charges included in it, if not put in the form of a service charge, would mean an additional increase in the rate per thousand. He should be informed approximately how much more this would be—the amount is much more than he would think. The inestimable value of the service charge is in decreasing the commodity charge and thus encouraging increased consumption.

While the service charge allocates certain expenses so that the costs of operating the distribution system, as well as some of the capital charges, are prorated on a more equitable basis than would be possible without a service charge. This is only the first step in the formulating of a correct rate structure. The great demands of very short duration that the domestic heating consumers place on the distribution, transmission and production system constitute one of the most perplexing problems that a natural gas company has to contend with.

The small consumer uses gas primarily for water heating and cooking and uses it consistently every day of the year. There is no reason why he should be penalized for the peak load conditions placed on the system by the heating customers. The commodity and service charge should be high enough to reimburse the company for its operating expenses as well as the capital charges on the property useful to him. Such operating expenses and capital charges beyond these items should naturally be allocated to those who create these demands.

Example Is Cited

We will suppose that a city exists about 150 miles from where the company purchases its supply of gas. In the summer, the requirements of the domestic consumers are approximately 30,000,000 feet per day or not the capacity of one 18-inch transmission line. However, to meet the requirements of the domestic heating consumers in winter, four such lines are necessary. A further analysis shows that two lines are sufficient for spring and fall heating, three lines for the normal winter demands, while the fourth is necessary for a few hours per day on probably not more than 10 or 20 days during the entire year when the coldest weather occurs. The capital charges for these additional lines, as well as the cost of operating them, together with such equipment in the distribution system that is necessary because of these extraordinary demands for gas are properly chargeable to the heating consumers.

From a purely theoretical standpoint, the correct method is to place demand meters in each house and definitely measure and charge each consumer for the demand he places upon the system. However, it is not always practical to work this out with the rate making authorities, especially in places where the company deals directly with the municipalities rather than through a state regulatory body. The chief objections other than those stated above consist of the tremendous investment necessary in the purchase and installation of limiting devices for each consumer, and a large trained personnel to estimate and advise the customer as to his probable demand. We believe that these devices would be a means of constant service and expense due to the great amount of moving that is done in large cities and the consequent change in the demand of the new tenant.

Sliding Scale Upward

The question raised as to whether or not it is much better to measure a consumer's demands by the month through the regular reading of the volume meter and make the demand charge in the form of an upward sliding scale with the lowest bracket as the commodity charge and the upper bracket as the demand charge. It is of course recognized that in certain cases this rate is discriminatory on certain customers but unless you go to a four part rate with all the complications attached to it, you are going to have examples of inequity in any rate, from the flat rate as the worst offender up. In many cases, at the present time, the most practical rate to install is one which embodies the three cardinal principles of a proper rate structure; namely, a commodity, service and demand charge and also one that can be put into effect with the least amount of expense and inconvenience to the company and customer alike.

The sliding scale upward, in connection with a service charge, approximates these results and can be put into operation without any of the accompanying costs and charges incurred by the demand rate and which the customer must eventually pay. As before stated, also, the customer may, under the sliding scale, change his demand any time he desires and as often as he desires, without any of the inconveniences that are incurred when doing so under a three part rate.

In many gas fields, especially the Appalachian region, the question of a diminishing supply is an important one. Naturally, it is desired to furnish the customers with straight natural gas as long as possible before going on a mixed gas basis. Here again the peak day in winter must be contended with. The sliding scale upward definitely reduces the peak day demands to a remarkable degree, prolonging for a number of years the time when the supply must be augmented with manufactured gas. It is a common practice, under a sliding scale of rates, for many consumers to use gas until they have reached the higher brackets in the step-up rate and then substitute some other fuel for the remainder of the month. This is, of course, desirable only where there is difficulty in maintaining a supply on peak days.

The argument is made that gas is used as a necessity for cooking and water heating and as a luxury for house heating. On this theory it is contended that it should be sold as cheaply as possible to the former and at a higher rate to the latter. This has been a popular appeal and many times an advantageous rate can be agreed upon very readily, where an immense amount of investigation, expert advice, opinions and testimony, public hearings and great outlays of money for additional equipment and operating expenses would be necessary to sell the three part rate and it is a great question whether or not the small difference in results warrants such large expenditures.

Sliding Scale Downward

A totally different set of conditions, equally important and pressing, in a gas company's business, requires a still different rate treatment, and this may be best met by a sliding scale downward. These conditions can be summed up briefly as follows:

Natural gas companies are in business to sell gas to domestic consumers and they have been organized and their plants laid out with this in view. They are confronted, however, with the unfortunate situation of having a large portion of their equipment idle a great deal of the time, some of it being needed only on extremely cold days and then for only a short period each day.

If by utilizing this idle capacity in seasons when it is not needed for domestic requirements and by the addition of a small amount of equipment, they are in a position to take on a considerable volume of new business the question is raised as to whether this additional business should be charged for its prorated share of the entire plant or for only the additional capacity required.

In order to obtain this new business, which is always of such a nature that gas is sold on a strictly competitive basis with other fuels and is in no way essential to these industrial plants, the rates must be entirely independent of those charged to domestic consumers and usually much lower. It is merely an application of the telegraph company, in giving special rates to night letters. These competitive prices must be met, of course, with a step-down rate, as it would certainly be uneconomic for a company to have a large portion of its plant idle most of the year when it is possible by a correct allocation of costs to obtain a large volume of business even on a very close margin of profit. Any amount over the cost of gas and the additional capital charges necessary to take in this business and the additional expenses incurred, will eventually revert to the benefit of the consumer as well as the company.

Have you heard the New Scotch Story about a tight gasket named McKim?

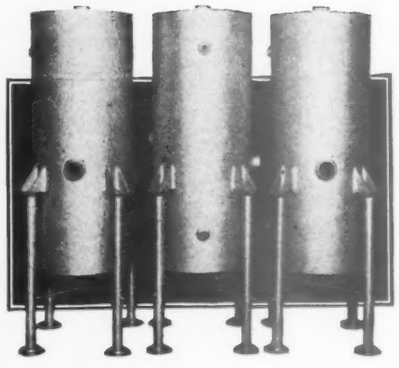
[the original Metallic Asbestos Gasket]

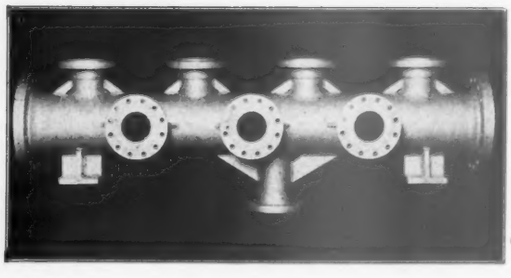
McCord Radiator & Mfg. Co.,
DETROIT

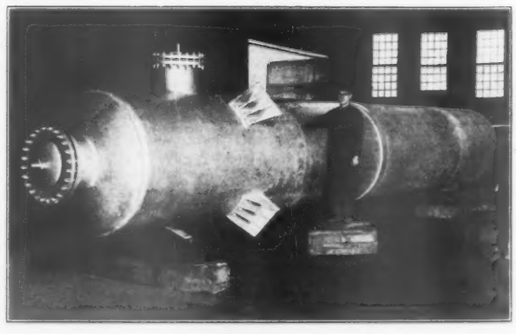
Serving the Gas Industry's Varied Needs

Power Piping
FOR EVERY INDUSTRIAL NEED

POWER PIPING CO., PITTSBURGH, PA.







Plant of Power Piping Co.

Methods Employed in Mid-Continent

Drilling Operations, Care and Maintenance of Wells, Pressure Conditions and Caring for Water Explained

By A. W. Leonard

When one considers the many problems of the conservation and control of natural gas during drilling operations and of the care and operation of producing gas wells and of the abandonment and plugging of depleted wells he immediately realizes the necessity of a thorough knowledge of general practice for the successful development and maintenance of gas properties.

It is true that the practical handling of natural gas assumes different angles in different localities, but certain statements may be made that readily apply to Mid-Continent operations in general.

In certain localities the rotary method of drilling is far more successful than cable tools in drilling through gas sands, clay and soft shale. The cable tools are much to be preferred for wildcatting and drilling in.

The escape of gas from a well during drilling can be controlled and formations can be sealed to prevent the waste of gas.

It is possible, by sealing off gas with mud-laden fluid, to drill entirely through a gas-bearing sand without wasting gas.

The sealed formation may be reopened at any time by removing the fluid from the well, the pressure of the gas cleaning out the mud.

The demonstration by the Bureau of Mines shows that the waste of natural gas in drilling and casing oil and gas wells is entirely unnecessary and may be prevented by suitable precautions.

Precautions Outlined.

These precautions may be outlined as follows:

1. Seal each gas-bearing stratum, as it is encountered, by drilling with the hole full of mud-laden fluid.

2. Set each string of casing with a secure and water-tight seat, using a long casing shoe to assure tightness.

3. Keep the space between the pipe and the wall of the hole full of muddy fluid when casing through a gas-bearing stratum.

4. Place a gate valve on top of the inner string of casing before drilling into any gas sand.

5. The string of casing through which gas is to be taken should be seated on top of the gas sand and the gas should be prevented from coming in contact with the wall of the hole above the casing seat. This precaution should be observed when gas is to be taken through a bradenhead at an oil well.

The mud-laden fluid or mudding-in process appears to be in general use wherever rotary drilling is used and those best informed express the opinion that this process is very well adapted to the plan of drilling generally followed in the Mid-Continent fields. The process is described as being simple in preparation and not difficult of application and has been in use in Oklahoma since 1914. It has proved its practicability and its use is recommended by the Bureau of Mines.

In this paper the term "mud-laden fluid" is applied to a mixture of water with a clay that will remain suspended for a considerable time. The fine sticky clays that in many places are termed "gumbo" are well suite for this purpose. Recently we have used a manufactured dry product which has a specific gravity of 4.28 and weighs 270 pounds per cubic foot, yet remains in suspension and when mixed with mud becomes very slimy and is an ideal wall builder.

Mud-Laden Fluid

Some have thought that mud-laden fluid implies any of the drillings from a well; but this is not the case, for any coarse material such as sand or lime will quickly settle out and prevent the bit from striking the bottom of the hole. Others have thought that clear water should have the same effect as mud-laden fluid, but the result of trials has proven otherwise. Some gas sands have been permanently drowned out as a result of the use of clear water, the water continuing to flow into the sand because of the absence of the clogging effect of clay. Clear water will also tend to cause the wall of the hole to cave and its use often results in "frozen" pipe.

The action of mud-laden fluid on gas sands or other porous formations may be likened to the action of muddy water passing through a filter. In any filter that has been used for some time it will be found that most of the sediment from the water has been deposited on the surface, but some of it has entered the filter, the proportion diminishing with the distance penetrated. The extent to which a mud-laden fluid will penetrate a gas sand depends upon the porosity of the formation and upon the excess of pressure created by the slush pumps used and the column of fluid in the hole. This mud so completely seals the formation that in a short time no water will pass from the hole into the gas sand.

The proportion of clay that should be mixed with the water to insure the best results is about 20 per cent by weight. With this proportion of clay, it is impossible for the driller, no matter how experienced he may be, to notice any material effect in the action of the tools, for they work about the same as they would if the hole were filled with clear water. In cold weather this proportion may have to be reduced as low as 8 per cent.

In order to save time in preparing the clay and water mixture for a well it is recommended that an extra slush pit about 30 feet long, 15 feet wide and 5 feet deep be dug close to the derrick. This pit should be placed on the low side of the derrick in order that bailed fluid will gravity into it. When the well is drilling through beds of clay, the drillings can be turned into this pit as they are bailed from the well and thus be kept separate from sand and shale drillings. Care should be taken to keep this fluid free from heavy particles that will not stay in suspension.

Quantity to Be Used

Determination of amounts of mud-laden fluid to be used depends upon the depth of the hole and upon the porosity and thickness of the sand or sands which are not cased off. Personal experience has proved that there is no well too large in volume or rock pressure but can be shut off if there is one string of casing in the hole on which a bradenhead or "lubricator" may be attached. Through these the mud-laden fluid can be pumped into the hole.

A "lubricator" consists of a 40-foot length of 6-inch or 8-inch casing placed above the master gate and securely anchored to the derrick. A relief valve is placed at the top of the lubricator to vent the casing while filling. This 40 feet of casing is pumped full of mud-laden fluid with the master gate closed. Lubricator having been filled, the relief valve and pump line valves are closed and the master gate opened, allowing the mud-laden fluid to be displaced by gas.

In Oklahoma wells testing from 80,000,000 to 100,000,000 cubic feet open flow with as much as 1,430 pounds rock pressure have been lubricated and completely shut in without wasting any gas.

This process may also be used for lubricating tools and shots into a hole. In one case a string of tools was lubricated into $5\frac{3}{16}$-inch casing when the well was making 25,000,000 cubic feet of gas from top of the oil sand. Shots have been successfully lubricated into wells making 2,000 to 3,000 bbls. when the shell could not be placed otherwise.

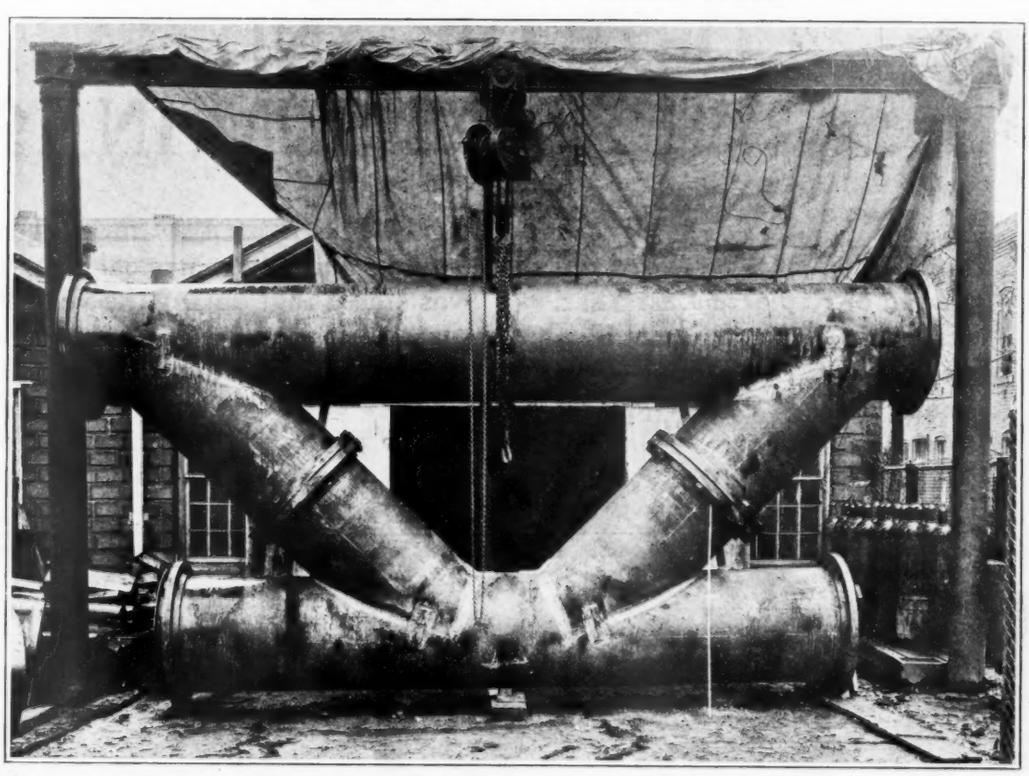
Opening of a sealed sand to recover the gas is accomplished by bailing down the fluid until the gas pressure is sufficient to raise the mud and clean the hole.

After a gas sand has been mudded in and is brought back as a gas well, considerable time should be allowed for the sand to clean itself of mud-laden fluid before the well is turned into the line.

The most evident waste of natural gas occurs when a well is allowed to go "wild" after being drilled in. Large quantities are also lost due to the fact that proper methods are not used in setting the casing. This is especially true where formations are loose and good seats are not to be found.

Other wastes of perhaps as great importance occur in drilling by the usual methods. Gas is often allowed to escape freely while a well is being drilled through a gas-bearing sand in search of oil. In some wells an attempt is made to save the gas for future use by shutting it in with a string of casing using a packer at the bottom of the string and a breadenhead at the top. Between the packer and the bradenhead there is usually a large amount of open hole in which the gas is confined in contact with all strata penetrated. Much of the gas enters the more permeable strata, sometimes forcing its way to great distances and is lost. If the bradenhead is opened at a later day the once available supply of gas has decreased to such an extent

A NICE, DAINTY, LITTLE WELDED FITTING

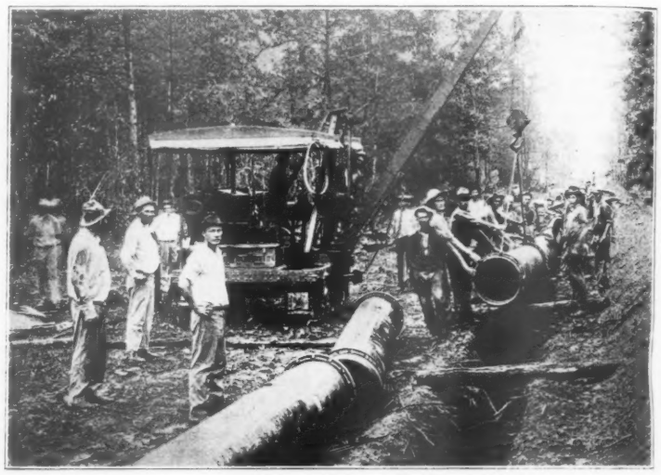


Employes of one of the gas companies in Pittsburgh welded this fitting for a 48-inch line of the company. The white line represents a height of 6 feet.

BITURINE

THE WORLD'S LARGEST NATURAL GAS LINE

This line, 22" in diameter, laid between Fowler, La., and Baton Rouge, La., was designed and built for the Interstate Natural Gas Co., Inc., by Ford, Bacon & Davis, Inc., New York. Pipe laying by Williams Bros., Tulsa, Okla. That portion of the line laid in Louisiana between Fowler, La., and Natchez, Miss., (approximately 90 miles) coated with Biturine Enamel.



PIPE LINE CORROSION COSTS OIL AND GAS INDUSTRY HUGE SUM IN 1925-26

1200 Miles of Pipe Line Repaired or Replaced Last Year. Experts Claim Proper Protective Coatings Would Eliminate Large Proportion of Maintenance Costs.

At the February, 1927, meeting of the American Institute of Mining and Metallurgical Engineers in New York City, it was stated that during the year 1925-26, at least 1200 miles of gas and oil pipe line had to be repaired or replaced due to the ravages of corrosion. Experts discussing the oil and gas industry's corrosion problem, declared that the application of proper protective coatings on metal pipes would largely eliminate the uneconomic waste involved in pipe line maintenance.

BITURINE

ENAMEL

Biturine Enamel prevents corrosion permanently

For more than sixteen years many leading oil and gas industry executives have been successfully solving the pipe line corrosion problem with Biturine Enamel—the permanent corrosion preventative. Hundreds of miles of pipe line have been coated with Biturine Enamel and the largest operators in both the oil and gas fields have pronounced it entirely successful in giving permanent protection.

Applying Biturine Enamel.

Unaffected by acids, alkalis or electrolysis

Biturine Enamel is a heavy quick-setting bituminous coating, tough but not brittle. It is applied hot and requires no wrapping. Adheres tightly to metal and will not crack. It is absolutely impervious to corrosive elements.

Biturine Enamel is manufactured by Hill, Hubbell & Company as one of a special line of paints for the oil industry. Biturine Enamel is supplied with directions or applied by the manufacturer under contract.

Valuable, practical data and specifications furnished on request.

HILL, HUBBELL & COMPANY

Manufacturers of

Highest Grade Oil Industry Paints and Pipe Line Coatings

Factories at SAN FRANCISCO and TULSA

DISTRICT OFFICES

331 W. Eleventh St.
LOS ANGELES
2412 First Ave., S.
SEATTLE

1006 Washington Ave.
HOUSTON
51 First St.
PORTLAND

15 Moore St.
NEW YORK CITY
600 E. Lombard St.
BALTIMORE

ENAMEL

that it is of practically no value to the owner. This subterranean movement of natural gas sometimes leads to the rejuvenation of exhausted gas sands and also constitutes a formidable danger by establishing "stray sands," the unexpected encountering of which at other wells may result in blowouts and gas fires with attendant loss of life and property.

Getting Gas Unexpectedly

When a large volume of gas is encountered unexpectedly during drilling, in a hole that carries no casing except a short piece of conductor pipe, the usual method followed is to drill on through the gas sand. Eight or ten-inch casing, depending on the size of the hole, is then run and set on the bottom. The casing string is pumped full of mud-laden fluid and while the pumping operation is in progress the pipe is raised slightly. Thus by equalizing the mud on the inside and outside of the casing the gas sand is entirely sealed off. In operations of this nature the largest diameter of pipe possible to run in the hole should be used. For instance, the volume of the resultant column of mud in 6-inch casing in a 10-inch hole in most cases will not be sufficient to overcome the gas and a blowout will result.

When a string of casing will not entirely shut off a well or when working in a "cavey hole" a string of 3-inch pipe perforated at the bottom is run with a bradenhead. Mud is then pumped through the 3-inch which is equipped with a check valve at 100 feet to 200 feet from the bottom. This check valve is to keep the tubing free of mud after lubrication is completed. The gate valve on the bradenhead is cracked enough to permit the mud to advance up the hole but not enough to do away with back pressure. The mud will eventually appear at the bradenhead and in a short time will kill the flow of gas entirely.

In both rotary and cable drilling free circulation should be obtained before cementing. The mud-laden fluid in the hole may be slightly thinned, but not to the extent of starting the hole to cave. Where the formations above the gas sand are hard it is best to case and cement 30 feet to 50 feet above the sand, thus insuring plenty of room for another attempt to cement in case of failure.

Cement should be allowed to set 5 to 10 days, but should not be run into the hole before it has been tested for setting properties with the mud and water already in the hole.

If water develops after the cement has been drilled out it should be analyzed and compared with samples of upper waters which has been taken during drilling.

Seals should be placed at the top of different strings of casing which are left in the hole to protect the pipe from atmospheric corrosion and salt water.

Cement enclosures around the well connections, leaving gates exposed, are recommended. Casing should be anchored to "dead men" as dependence cannot be placed on anchorage to the derrick foundations or strings of casing. Casing should be tested in the hole before drilling into large volumes and high-pressure gas.

One Well to 40 Acres

A gas well will drain a larger area than an oil well. Therefore, in proven territory gas wells are usually located one to each 40 acres, while oil wells average one to every 10 acres.

Gas sands within the same area are usually tapped with the same size drill hole and finished with limited sizes of casing and tubing. Open flow on all wells in the same sand should be taken through the same size opening.

Under the conservation rules of our Corporation Commission, the maximum amount of gas that can be taken from a well in any one day is 25 per cent of the open flow. In Osage County, which is under the supervision of the United States Government, this quantity is 20 per cent.

To eliminate the waste which is caused by taking the open flow each month, the Corporation Commission of Oklahoma is now trying to bring to the natural gas industry a method of determining the amount of gas that can be taken from a well daily without having to blow the well. We, of Oklahoma, believe this new method of taking the percentage of open flow is a step forward in the natural gas industry toward conservation.

A close co-operation with the Bureau of Mines and Bureau of Standards, who have already been of great value, will lead to the adoption of more practical methods of conservation and the revision of theories that are impractical.

A plan has been worked out to guarantee absolute fairness to producers in the amount of gas taken from their respective wells each month. In each district a certain percentage is decided upon at the beginning of the month. This percentage, which is based upon the actual open flow of the wells, is used as a standard in each particular district, and as nearly as possible enough gas to make that percentage is taken from each well in that district. To accomplish this result, the men in the field offices keep strict watch over the daily deliveries from the wells and each day figure the accumulated percentage that has already been taken.

Maintain Certain Pressure

It is of the utmost importance to the life of gas wells to control the deliveries from them in such a way that a certain pressure is maintained on the sand in the territory surrounding the well. This pressure should be sufficient to allow the well to produce at the maximum rate without shortening the well's life or limiting the ultimate recovery of gas. It is possible to determine the minimum pressure to be held on the sand for the practical maximum recovery and it is possible to maintain such pressure.

Pressure analysis makes it possible to determine many conditions of the well with respect to underground waste. Pressure records give data on which to base the future delivery rate and reserves, and result in a more efficient control of wells.

Wells should not be permitted to produce from different sands through the same string of casing.

The freezing of control lines has been overcome by the use of various types of heaters, regulating by-passes and control orifices.

Orifice meters are being used on large capacity wells and main lines. They are now used successfully in the measurement of drilling gas.

Proper sized drips should be installed within a hundred feet of the well connections to trap any fluid, sand or mud from the meters and main line.

Meter gates should be packed with asbestos packing which will not burn out in case of fire. There have been many well fires in the Mid-Continent Field. One well with 100,000,000 feet open flow in a 10-inch hole was extinguished by a 7-quart shot of gelatin, three hours after the shooter had arrived.

In another well fire the gaskets burned out of the gate valves. The heat was intense and even with streams of water and asbestos suits it was impossible to get near the well. The open flow was approximately 75,000,000 feet with 1,000 pounds rock pressure. A trough was made and by the use of a wire line gelatin was pulled near the gate and exploded. The gate was shot off and the gas confined to one flame, blowing from the casing. This was shot out on the third attempt with the use of gelatin swung from a 2-inch pipe tripod.

In many of the older wells we have found that encroachment of water is beginning to show. As long as the rock pressure is great enough, most of the water will be held back in the sand or be carried off with the gas as a mist, but as the rock pressure declines the water starts to take possession.

Water in Wells

Where a well makes water in large quantities and where the difference in the well working pressure and line pressure is great enough and where there is a continuous demand for gas, the required delivery can be taken through a siphon line. In this manner the water is brought to the surface with the gas, where it is separated by traps or drips. Where it is desired additional gas can be taken both from the casing and siphon.

In a number of instances casing collar leaks from 500,000 to 1,000,000 cubic feet a day have been shut off by lubricating wells inside the string of casing with heavy asphalt paint.

On high pressure wells the master gate is operated by use of a "crow-foot" which is attached to the wheel of the gate. To the crow-foot is attached 40 feet to 60 feet of 4-inch pipe. The gate may then be opened or closed at a safe distance from the derrick floor by use of tongs on the 4-inch pipe. One well of large volume and high rock pressure was opened in this manner and an abandoned string of tools were brought out of the hole, throwing the tools 100 feet into the air and dropping them at the corner of the derrick. The bit entered the ground several feet, bending the stem and leaving the neck of the rope socket near the engine house.

The methods of abandonment of wells in the Mid-Continent Field are entirely satisfactory, if proper precautions are used in putting mud or drillings back into the hole in such a manner that the mud does not bridge.

In case mud-laden fluid is used, the hole should be kept filled until the mud stops settling. In one instance a well was drilled to the deep sand where a hole full of water was encountered. The well carried 2,600 feet of 6⅝-inch casing with a total depth of 3,300 feet. In abandonment the well was filled to the top with mud and an attempt was made to pull the 6⅝-inch casing, but the casing would not start. The well was then bailed down to the bottom of the casing, leaving approximately 600 feet of mud in the hole. The lower water did not break through this short column of mud. It was then possible to pull the casing, demonstrating that a hole full of water was shut off and held by 600 feet of mud. The use of cement and plugs is also recommended in abandonment of wells. Notice should be given to adjoining lease owners of abandonment of such leases.

The Osage Nation conservation officers prefer the use of dry sand pumpings, claiming they will settle more readily and displace the water. When the pumpings have thoroughly settled in the hole a cement cap is placed over the abandoned well.

Each well has its own peculiarities and is a study in itself. However, the period of productivity of gas wells can be materially prolonged by care of production in drilling; by proper casing of wells; by saving gas from oil wells; by controlling and capping wild wells; and by improved methods of conserving the gas during drilling operations.

With the proper care of gas wells and the equitable regulation of the amount of gas taken from a common source of supply, we can enjoy this natural resource for many years to come.

THREE-PART NATURAL GAS RATE EXPLAINED; ADVANTAGES LISTED

By T. J. Strickler
Vice President and General Manager, Kansas City Gas Co.

Rates are probably the most vital single factor in the problem of the utility. An increase in a flat rate to the customer is not always the answer to the problem. Our study of the problem forces us to the conclusion that the proper type of rate is the reservation rate, made up as follows:

The Customer Charge

The customer charge includes a certain portion of the fixed charges on the value of the property devoted to the customer's use, which is in direct proportion to the number of customers served, such as the value of the meters, services and those parts of the distribution system and other property maintained and used for the customer's service and benefit. These charges include taxes, insurance, depreciation and a fair return on the fair value of the property.

This charge also includes not only the cost of reading the meter, which it is popularly supposed to cover, but cost of keeping the customer's accounts, collecting the bills, free complaint service, setting, removing, changing, repairing and testing meters, maintenance, replacement, inspection and testing of customer's services, office rent and other general expenses of a like nature, particularly applicable to and caused by customers' needs.

All of the above expenses are in proportion to the number of customers and the company must bear such expenses throughout the year, regardless of whether the customer makes a large or small demand upon the system for gas, or regardless of whether or not the customer uses any gas at all.

If these costs are not paid for by each customer who creates them, then they must be paid for by other customers if the company is going to be able to pay operating expenses and earn anything for depreciation and a fair return upon the value of the property.

The customer charge means only that each customer pays his fair share of the cost of the service which he creates.

Reservation or Requirement Charge

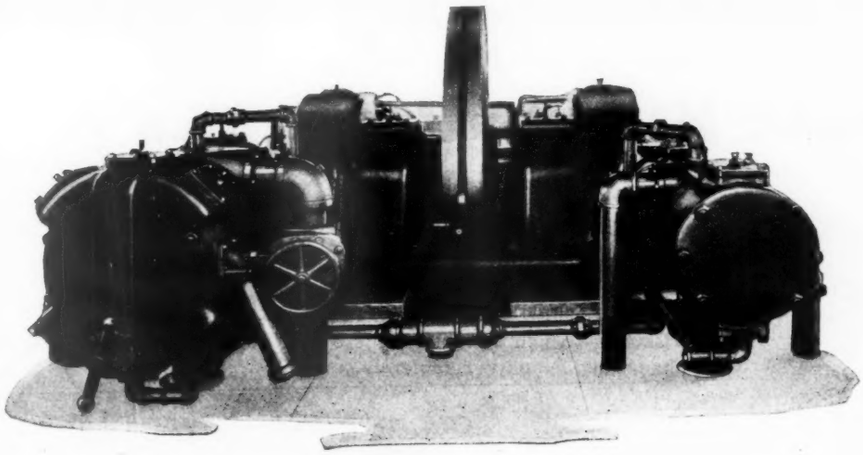
The reservation charge includes a certain portion of the fixed charges on the value of the property which must be constructed to meet the total maximum hourly demand which may be placed upon it. This is the second part of the cost of service and is measured by the total maximum hourly demand, expressed in cubic feet per hour, of all the customers. It consists of that part of the company's expenses necessary to provide and maintain a production, transmission and distribution system of sufficient capacity to render service. The principal elements of this cost are the fixed charges such as taxes, depreciation and return upon the value of the property necessary to meet such reservations, and a part of the operation and maintenance expenses on the same property. This charge is in proportion to the total demands or reservations contracted for by each customer and hence should be distributed among the customers in the proportion by which each customer contributes toward the creation of this expense.

Commodity Charge

The commodity charge is the third part of the cost of service and includes those costs which are measured by the volume of the commodity handled and are not affected to any great extent by the number of customers or the maximum hours of demand that may be placed upon the system. It represents the cost of the commodity handled plus a certain proportion of the cost of maintaining and operating a transmission and distribution system. In other words, it is the cost of the commodity delivered as distinguished from the cost of service.

Our experience proves that such a rate as opposed to the flat rate—

1. Increases the number of consumers.
2. Increases the gas consumption per customer.
3. Lowers the average rate per 1,000 cubic feet.
4. Allows the maximum amount of service and sales with the minimum expenditure.
5. Allows consumers to take advantage of a decreased price per unit for quantity purchased, and thereby use gas for purposes that a straight flat rate prohibits.
6. Does not penalize the poorer class of consumers.
7. Does not penalize the small consumer regardless of his station in life.
8. Allows the utility to give better service by enabling it to forecast in advance the demands which will be made upon its lines.
9. Forces each class of consumers to pay their just share of expenses they create without penalizing any other class.



Look Before You Leap!

The time to learn the history of a product is before you buy it.

The history of Watts-Miller equipment is an open book that all may read who will—and those responsible for the purchase of gas engine and compressor equipment owe it to themselves to read carefully.

Those who investigate prior to purchase instead of afterwards will learn that Watts-Miller Units are in more general use than any other make:

because Watts-Miller equipment delivers a degree of non-stop, uninterrupted service unequalled by other makes.

because Watts-Miller equipment operates on continuous, 24-hour schedules with very little servicing, and surprisingly little upkeep expense.

because Watts-Miller equipment always proves its ability to deliver full 100% of the capacity contracted for—with a liberal excess thrown in for good measure.

Let your investigation of gas engine and compressor equipment cover all makes and let it be thorough—in order that you may infallibly choose the best. In other words, look before you leap.

The Miller Improved Gas Engine Co.

Tulsa, Okla., Office
323 No. Cheyenne Ave.

Springfield, Ohio

Los Angeles Office
807 San Fernando Bldg.

WATTS GAS ENGINES AND COMPRESSORS **MILLER**

The Gas Industry Profits by these Butler Products

Where field conditions permit we recommend the welded tanks.

Butler Welded Field Tanks are made of the best grade of open hearth blue annealed copper steel or

Butler Welded Oil Field Tank.

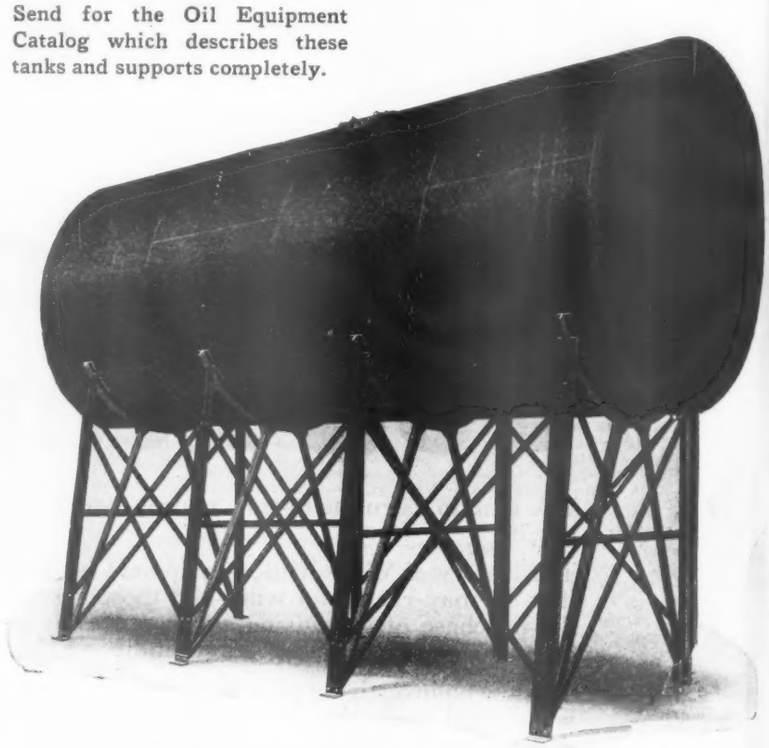
3-16″ and heavier tank plates of special welding quality. All seams and connections are welded.

Each tank is tested under air pressure to insure its being oil tight.

Where the welded tank cannot be used, the Butler Bolted Pressure Tanks are recommended. They may be set either as flow tanks or as stock tanks.

In storing casing head gasoline the Butler Welded Horizontal Tanks will be found a big economy. All seams and connections are welded. Each tank is tested under air pressure.

Send for the Oil Equipment Catalog which describes these tanks and supports completely.



Butler Welded Horizontal Tank for storing casing head gasoline.

The picture at the right will give you an idea of how oil men are economically using Butler *Ready-Made* Steel Buildings.

Butler Buildings are made of 24 gage galvanized steel. Each sheet has deeply drawn paneled corrugations which give it added strength.

Many pictures of buildings now being used by oil men are shown in the Butler Building Catalog. Send for a copy today.

Butler Ready-Made Steel Building for compressor house or gasoline plant.

STEEL BUTLER PRODUCTS

Butler Manufacturing Company

Kansas City, Mo. **Minneapolis, Minn.**

Foreign Department: Kansas City, Missouri

Storing Gas in Old, Depleted Fields

Areas Near Markets, in Many Instances, May Present Enormous Natural Reservoirs of Great Use in Winter

By A. W. Lee
General Superintendent, Louisville Gas & Electric Co.

Nature's Storehouse May Solve Problem

Natural gas companies must care for demands in winter that are from two to five times as great as demands in summer. The big problem is to have available sufficient gas to meet these requirements.

One company, experimenting in Kentucky, has used the old Menefee Field for 10 years as a reservoir in which to store gas during summer months when the demand is not so great and in taking this gas from this old field in winter when the fuel is needed most.

No unusual losses have been experienced with gas placed in this natural underground storage and it is said over 25,000,000 feet is stored there each summer to be withdrawn the following winter.

Individual wells are important factors in this connection, investigations having proved quite often a well is drilled in a lens and that this lens provides an ideal place in which to place gas during summer months and recover it for use during the winter. One such well had a storage capacity of 25,000,000 feet at 400 pounds pressure and was filled and emptied at least six times last winter.

It is rather presumptuous for any one to discuss a subject about which so little is known, and this paper is given, therefore, to start constructive thought and criticism rather than to prove a personal conviction.

Would it be proper to suggest at the start, that a thorough investigation and study of the subject by the Bureau of Mines would prove of inestimable value to every producing and transporting company in the country?

Very few natural gas companies have any holder or storage facilities and even when they do have, the amounts are so small in proportion to the daily load that the storage will take care of the demand for only a few hours at best. Yet all such companies must take care of daily demands in winter that are two to five times the daily demands in summer.

To meet such winter demands the producer has to drill extra wells that are idle most of the year and the transportation company has to install lines and pumps that are used to capacity only a few days in a year.

Abandon Near-by Fields

At the same time, every producer must yearly abandon certain wells and every transportation company must from time to time abandon certain lines and stations, and of vital significance is the fact that those wells and stations first abandoned are usually in fields nearest the markets. In other words, the general history of the industry shows that fields nearest markets are the first to be exploited and that the original system then grows further and further afield, seemingly without limit. While this is occurring, the original wells and fields are gradually being abandoned and the gathering lines are being torn up for re-laying. Is it necessary to point out that the nearer the market, the more valuable the storage?

Since many of these fields could be used for storage purposes, does it not seem rather short-sighted to overdrill new territory for the purpose of meeting winter peaks and yet abandon perfectly good storage reservoirs in which good money has already been sunk?

One Concrete Example

Perhaps a concrete example will make the question clearer: In 1901 a shallow gas field was discovered in Menefee County, Kentucky and after the usual promotion difficulties gas was piped to Lexington, Ky., in 1906. Both field and lines were owned by one company.

The field supplied the company's markets for only three or four years and they were compelled to continue their main line about 100 miles to the east to procure West Virginia gas. The original field was only some 40 miles east of Lexington.

Even with this new supply, the Menefee Field was still drawn on, until, 1916, the rock pressure was down to 29 pounds.

At this time the company was transporting practically all its gas from West Virginia, carrying it past the Menefee Field to Lexington. Only a small quantity could be procured from Menefee and because of line pressure conditions, that quantity in summer when gas was a drug on the market.

The situation has been paralleled in many locations, and in the usual course of events, the field would have been double-staged and then abandoned.

The officials of the company, however, with real foresight began to experiment with the field as a storage reservoir, putting in gas in summer and reclaiming it in winter. And now in 1926, after 10 years experience, they feel the experiment has proven a success and consider the storing of gas in summer as normal operation.

Big Natural Reservoir

No water troubles or unusual losses have been experienced. Our information is that over 25,000,000 cubic feet is stored each summer for withdrawal the following winter—a very respectable storage when you consider that the annual market of this company is between 2,000,000,000 and 3,000,000,000 cubic feet.

Five years ago our company brought in a well in eastern Kentucky which showed 15,000,000 feet the first day, 5,000,000 the second, 1,000,000 the third and in a week had tailed down to about 200,000 per day. Subsequent drilling proved it to be in a lens, practically isolated, with a storage capacity, at 400 pounds of about 25,000,000 cubic feet.

From the usual standpoint this well was hardly worth plugging, but it was immediately connected up as a storage proposition. During this past winter it was filled and emptied at least six times.

Further to prove our confidence in underground storage, our company has just finished buying up all the production in a small field in Magoffin County, Kentucky, covering some 1,500 acres, the gas from which is one-half gone. The entire purpose of this purchase was to use this field for summer storage, our investigation showing it can safely hold about 3,000,000,000 feet when boosted from 100 pounds rock pressure to 300 pounds rock pressure; the water conditions are right, the gas can be reclaimed in winter at a 5,000,000 to 10,000,000 cubic feet per day rate, with the same lines, compressor station and labor costs that are now producing 2,500,000 cubic feet to help carry peaks. We believe we have secured a very valuable holder for a very small price. Other isolated instances could be cited but these will suffice.

It will immediately come to your minds that in very few instances can a gas producing field be owned entirely by one company, but remember that if such ownership is the economical thing and we, of our volition, do not do this economical thing, some one else—usually a commission or a court—will step in and make us do it. We are all public servants to that extent.

If you feel you can not possibly find an entire field to experiment with, do not under-rate the individual well.

One Well Important

A certain well in Oklahoma proved to be drilled into a pocket of gas, failed utterly in six months. The takings therefrom, however, and subsequent drilling showed it to have tapped an isolated lens with a safe storage capacity of over 500,000,000 feet that could be drawn out in winter at a rate of 20,000,000 to 30,000,000 feet a day; and yet, if we are not mistaken, that well is plugged and abandoned today and stands as a total loss to the producer.

Summing it all up, isn't it reasonable to suppose that a reservoir furnished by nature which has successfully held gas for millions of years, will hold it just as successfully for a few months each year?

Our small experience has shown, however, that some points must be considered carefully before deciding that a particular well or field is suitable for storage.

Points to Consider

First. While actual ownership of an entire field is not necessary, actual control of gas withdrawals, by means of transportation lines or otherwise, is essential. Arrangements must be made with landowners to revise existing royalties.

Second. Complete records of drilling, gas recovered, casing, water, etc. must be secured and studied.

Third. Badly lensed fields should be avoided. Barren strata in such horizons will absorb the storage gas and give it up slowly.

Fourth. A porous, uniform sand would appear to be ideal since it will absorb and deliver gas more readily than a tight sand.

Fifth. Stick to a small well-defined field for the first experiments. If the field is sealed on all sides by liquid it is still more attractive.

Sixth. The fewer the wells the better the operation. Wells not in use should be carefully plugged, so that leaky casings or tubing will not cause trouble.

Seventh. Pressures should never be built up higher than the original rock pressure.

Eighth. Avoid fields associated with known faults, since leakage along the fault planes may occur.

Ninth. Avoid combination oil and gas fields. Stored gas will be lost as the oil is produced.

Tenth and last. It is hardly necessary to caution against leakage due to "open holes" leaky and unsystematic casing and tubing and leaky packers.

Aside from these, no set rules can be given, until a wider experience with a greater variety of fields has furnished the facts upon which to base them.

Each a Separate Problem

Each field and each transporting unit must be treated as an individual problem, seeking to determine whether or not the cost of securing control of the field and the cost of a probable recompression will show a saving over the cost of securing and transporting new production.

Undoubtedly cases will arise where a large extension of a transportation system may be delayed one or two years by using an old field for storage, thus saving that much interest.

By steadier operation, field costs per cubic foot can be cut.

Casing, tubing and pipe in the old fields that would be scrapped or abandoned with attendant loss to the operator may have its life increased many years.

TROUBLE THE PUBLIC DOES NOT REALIZE

Intangible Assets of Public Utility

Elements of Value Based Upon These in an Appraisal of the Organization Rendering Public Service

By John B. Tonkin
Vice President, Peoples Natural Gas Co., Pittsburgh, Pa.

The subject, "Intangible Assets of a Natural Gas Utility or the Elements of Value Based Upon These in an Appraisal of the Organization Rendering Public Service," is one of extreme importance to the natural gas industry. That there is a real factor of value hidden in the intangible assets of a natural gas utility will be readily recognized and admitted by anyone sufficiently familiar with the details embraced by the subject to form a competent opinion. I am convinced that more than 99 per cent of the so-called "public utilities" today face this problem, unprepared to show definitely from the recorded history and financial records in their files what these most valuable intangible assets cost; and while the officers of a "public utility" may have a definite idea of the value and be honest in their appraisal of the same, the fact remains that the basis for an adequate rate must include these intangible elements, and the state authorities must be first convinced, so the burden of proof rests with the utility.

Perhaps it will be well to digress and first sketch briefly such background as will enable all to understand our subject. Webster gives as his definition of a public service corporation "one organized to fill a public calling or to render services more or less essential to the general public convenience or safety." A general rule for determining whether a business is public or private was laid down by the Supreme Court of the United States in 1876 in defining same as "when one devotes his property to a use in which the public has an interest, he in effect grants the public an interest in that use and subjects himself to control by the public for the common good, to the extent of the interest he has thus created."

Early Rate Legislation

As we all know, private business is regulated only by competition, sometimes resulting in "the survival of the fittest," with possible profit rewards proportionate to the risks necessarily involved in the particular enterprise. For public service corporations, regulation by competition in the long run proved to be bad for the consumers, as the providing of an adequate return to two or more competing companies, having duplicated installations of distributing facilities, must necessarily add to the consumers burden—and being contrary to economic principles, would result in consolidations and monopolistic control.

State control of public utilities by direct legislation was an earlier form of regulation. At that time maximum rate statutes were all the rage and were generously passed at the urgent demand of rate payers, without proper consideration of the problems involved and entirely ignoring the conditions affecting individual companies. Such regulation was arbitrary, unscientific, unfair and incapable of being easily changed to meet new and unforeseen conditions.

Prior to the inception of public service commissions, by far the most popular and most widely employed form of regulation was that known as local control; but, lacking any specialized training in the technic of public utility business, the officers of the municipalities, generally controlled by political influence, more or less corrupt, were not in position to properly protect the interest of the citizens or to deal justly with the utilities.

State Commissions

Accordingly, experience having demonstrated that competition could not be trusted to solve the problem of securing fair utility rates, that regulation by direct action of the Legislature was inadequate, and that municipalities generally did not function to safeguard the interests of either the rate payers or the utilities, the policy of regulation through state commissions was adopted. These commissions were given broad powers over construction, financing and regulation of utilities, have established a uniform accounting system, eliminated discriminations between different classes of consumers (including policy of free service to municipalities), and have established proper standards of service. Railroads having been the first public utility to come under commission control, such commissions originally were and in some states are still known as railroad commissions.

These state commissions occupy the same relative position in regard to utilities as do our courts in the case of business generally, being empowered to take evidence in cases coming before them, with authority to render decisions on questions involved. They are privileged to inspect the books and records of the utilities, examine in their financial transactions, and make valuations of the property for the purpose of ascertaining the value of the property devoted to public service. The commission acts as an arbitrator of conflicting demands, protecting the consumer if the utility is unreasonable and vice versa.

Due to the economic disturbance caused by the World War and resultant unprecedented and unforeseen increases in prices paid for materials, wages and other costs affecting plant construction and operation, many of the previously sound utilities were on the brink of bankruptcy. Acting with vision and courage and notwithstanding the always popular clamor against rate increases, the public service commissions generally allowed necessary increases in rates and saved the country from a great industrial calamity, thus clearly establishing the value of the new form of public utility regulation.

Protect Investors

The commissions have made it a policy to protect the investors in public utility enterprises from ruinous competition, if the company is rendering adequate service at reasonable rates, and therein have been upheld by the highest court. The opinion of the commissions as to the desirability of eliminating competition from the public utility field has been very pronounced, with a view to preventing the waste resulting from a duplication of facilities, the cost of which must ultimately be paid by the public.

The production and sale of natural gas is a hazardous and uncertain enterprise, depending for its profitable existence upon finding reservoirs of gas in sufficient quantities to justify the large investment necessary for the drilling and transporting of a very efficient commodity to consumers. Essential operations of vast industrial enterprises are greatly benefited, by and often almost wholly dependent upon, the use of natural gas as fuel for their continued prosperity; and when used domestically it adds greatly to the comfort and convenience of those so fortunate as to have it available for this purpose. As a matter of public policy and in fairness to those engaged in the natural gas business, not only should rates be fixed to secure an adequate return for the capital and enterprise invested therein, but, in all fairness, must include certain factors pertinent alone to the utility supplying its patrons with natural gas, keeping in mind the fact that with each cubic foot of gas sold, the assets have been diminished, for, unlike other utilities, we are selling something that cannot be replaced.

Other utilities, whose service is primarily based on the production of water, steam, electricity, etc., may be really classed as perpetual, but the business of a vendor of natural gas, whether the gas is produced by himself or another, is in the first place limited as to duration, and when he is out of gas he will be out of business; in the second place, in a particular gas area, as wells decline, the field declines, requiring more capital for additional explorations, and the uncertainty of future supply necessitates an amortization plan that will provide for the ultimate return of the invested capital when the depletion conditions will no longer justify continued operations.

A Subject of Great Importance

Questions relating to rates always are of vital importance to the natural gas industry because the foundation of the business and the ability to continue service to customers depends absolutely upon reasonable rates being allowed by regulatory bodies having this matter in charge.

In the accompanying article, Mr. Tonkin covers a subject of paramount interest to every natural gas company executive and employe—the matter of the personnel of the company and of the value of a highly trained, efficient and operating organization in considering the assets of a concern.

The appraised value of a natural gas property and company, based solely on equipment and other physical property such as land and buildings, neglects to take into consideration one of the company's greatest assets and one which represents a great expenditure of both time and money and on which the company should be allowed a return on that investment. That asset is the personnel which makes the company a "going concern."

The highest courts have upheld the view that such an asset entitles the company to a greater valuation than that represented simply by its physical property but, as Mr. Tonkin points out, the interests of the natural gas industry would be materially advanced if some common policy could be adopted in regard to the inclusion of going value as an intangible asset in an appraisal of each company's property.

Since the income of a natural gas utility is derived from gas sold to consumers and the amount so received is dependent upon the rates in effect, when, because of changing economic conditions, the established rates are no longer sufficient to provide for carrying on the business and allow the investor a fair return on his investment, it then becomes necessary to petition the public service commission for permission to increase the rates.

In the foregoing, we have briefly explained the need of rate commissions to protect the rights of both consumer and utility, but the task of submitting justifying evidence that will convince the commissions that rates need adjusting is up to the utility.

In 1923, the Supreme Court of the United States rendered several important decisions on valuation cases, some in substance stating that a regulatory body desiring to fix a rate must determine the fair value of the utility's property as of the time of the fixing of the rate, taking into consideration the reproduction cost of existing plant at current prices, such reproduction cost to include cost of reproducing the property as used for the public service, viz., the cost of a plant capable of rendering the service being rendered by the existing plant.

The reproduction cost of an established natural gas utility must include certain very important intangible assets, which may be defined as those items of value to a going concern over and above the value of the physical property (land, buildings, equipment). Highest courts have repeatedly confirmed the right of a public utility to include in cost to reproduce utility plants such intangible assets in arriving at a fair valuation upon which to determine proper rates.

In discussing these intangible assets, authorities will differ in their estimates of the comparative values of each, will differ in the names of the assets themselves, but, for simplicity, let us divide these intangibles into two groups:

1. Overhead Cost of Organization and Construction: (a) An element of value is inherent from the preliminary expenditures incurred in the initial stages of considering the possibilties offered, also the cost of incorporating a company, securing leases for drilling operations, making surveys, securing franchises, and, as well, the cost of financing not only these preliminary costs but that of the entire plant's construction. To illustrate this, a study must be made to show possibilties for earning a reasonable profit on the amount that will be required to establish the utility and options must be obtained on essential property required.

After a sufficient volume of gas has been obtained from drilling to warrant additional expenditures, a corporation may then be formed and negotiations started in the securing of franchises for marketing the gas.

For a small sized company, the stock and bonds may generally be sold in the community, but in a large undertaking the financing can no doubt me most successfully arranged through a banking syndicate which will buy the entire issue and by maintaining a market for the securities, gradually pass the same along to the public. In the latter case the cost of necessary legal expense in preparing mortgages, printing of securities, advertising of securities and other incidental expense will be paid by the syndicate, which is reimbursed by the discount under par value paid to the company for its securities. This discount will vary with the condition of the market, the estimated risk involved, and will also be governed by the stand-

ing of the company's incorporators, etc. Even under the most favorable conditions, discount will in many cases amount to 10 per cent.

Distribution of Funds

In addition to the cost of securing money to carry out this phase of construction, let us turn to the distribution of these funds so secured, which we will classify as:

(b) The preparation of plans and study of conditions by the incorporators, assisted by competent engineers.

(c) Interest on funds borrowed or advanced during the period of preparation for an organization of the company.

(d) Interest or return of funds used during the period of constructing the plant.

(e) Drilling of dry holes and any other losses during construction.

(f) In estimating the cost of reproduction of a well-established utility, it will generally be found that it has acquired and is using in its operations, properties that have a greatly enhanced value at the present time over that at the time the same was acquired by the utility, which may apply to leases, rights of way, easements, franchises, real estate, gas purchase contracts—many or all of which may possibly have conditions such that the acquiring of the same at this time would either be costly or possibly prohibitive.

2. Going Value: This second group of intangible assets relates to the increased value of a constructed plant with the marketing load connected, having already passed through that period of development up to the time the company's operations are earning a profit, and we shall call same "Going Value."

Briefly stated, going value is the difference between a plant newly constructed and the same plant after it has obtained its markets, connected up its load, has passed through the experimental period of operations and is being operated successfully at a profit and may be considered as an established business.

This cost of connecting the load, therefore, includes the following items:

(a) Interest on funds used by the company, not only for the plant already constructed but also for additional construction work in laying the distribution lines to consumers as well as interest on funds used for the operation of the plant, up to the time the volume of business and rates obtained yield sufficient revenue to meet these requirements.

(b) Funds used in advertising and publicity. This does not mean merely advertising space in the local papers, telling the public that it is possible to secure gas in their homes, but, on going into a new locality, where the advantages of natural gas have not heretofore been available, a very real and costly educational campaign must be undertaken if a sufficient number of consumers is to be obtained to justify the heavy investments already made in anticipation of this business.

An extensive department must be maintained for the purpose of demonstrating the many appliances in which gas can be used to advantage, solicitors must be employed to properly canvass the community and with proper advertising support, by mail and local newspapers, attract and build up an interest for this service.

(c) Cost of obtaining contracts with consumers. In addition to the preliminary work done in the matter of advertising and publicity, before the consumer can arrange for a supply of gas it is necessary that a survey of the consumer's premises be made, either by a representative of the utility or by a plumbing establishment, to inform the consumer of the probable cost of preparing the premises, purchasing of appliances for the burning of gas, etc., and it is quite often a problem for a prospective consumer to finance the necessary installation. As this is a matter that must be arranged before accepting his application as a consumer, it is quite common for the utility to be compelled to finance such installation and equipment of the consumer's premises on a monthly payment basis, not for the purpose of profit for supplying the installation and equipment, but to speed up the work of connecting the load, all of which educational campaign is costly and in the case of financing installation of service lines and equipment on the consumer's premises, demands the further use of capital during this period of connecting the load.

Developing an Organization

(d) Training and developing an efficient organization in each department of operations:

In a new organization, employes must be trained to do their work and an organization, to be efficient, must work together in accord. To secure this requires considerable weeding out and breaking in of new employes, more employes being added as the business develops, and this process of addition and elimination must go on until finally a satisfactory, unified effort is obtained.

A natural gas utility that has been successfully established over a long period of years considers its personnel or experienced working force a most valuable asset. From experience, it is well recognized that it costs money to properly train men for the responsibilities required of them.

In the early stage of any organization, the lack of experience of the men employed must be offset by employing a considerably larger number than would otherwise be necessary.

(e) Other extraordinary losses during the period of experimental operation, among which may be named the following:

In a large distribution system, there are many thousands of joints, a great number of which will develop leaks shortly after the first being put into service. Naturally, all leaks cannot be repaired at once, it being estimated that it takes as long as five years to attend to all the leaks on a new installation, if the company is reasonably large.

Very often, after a new line has been put into service, the settling of the ground will cause shifting of the line, land slides will follow excessive rains, often causing breaks in the line, and resulting in serious losses of gas and considerable extra labor in making necessary repairs.

Repair shops must be installed and warehouses stocked with initial purchases of materials, tools and supplies necessary to carry on.

Even after the best engineering skill has been employed in designing the plant originally, special and unforeseen conditions make changes necessary; and, in some cases, costly errors in judgment have been known to develop which required changes in plant construction.

(f) Provision for a supply of working capital to carry on the company's operations after the preliminary period of operations has been passed.

Courts Uphold This View

Reference to the files of any legal library should reveal many court decisions upholding the establishing of a fair value for the intangible assets of a public service utility, it accordingly being necessary to mention only a few at this time.

(a) In the Indianapolis Water Co. case, November 22, 1926, the Supreme Court of the Unted States declared "that there is an element of value in an assembled and established plant, doing business and earning money, over one not thus advanced, is self-evident. This element of value is a property right and should be considered in determining the value of the property, upon which the owner has a right to make a fair return when the same is privately owned, although dedicated to public use." The court further stated: "The commission's engineer made no appraisal of going value. The evidence is more than sufficient to sustain 9.5 per cent for going value. And the reported cases showing amounts generally included by commissions and courts to cover intangible elements of value indicate that 10 per cent of the value of the physical elements would be low when the impressive facts reported by the commission in this case are taken into account."

(b) In a certain condemnation proceedings, the California commission allowed a utility company 2 per cent per annum, the difference between a normal return of 8 per cent and a minimum return of 6 per cent during the assumed reasonable development period of the enterprise, in addition to the physical valuation of the property, as compensation for loss during the development period.

(c) In Colorado an allowance of $300,000 was made for going value of a utility whose property, aside from going value, was fixed at $3,921,460.

(d) In one case the Idaho commission made an allowance of $18,300 for the going value or development cost of a business, the physical value of which was placed at $207,399.31.

(e) In Illinois, the commission made an allowance of $125,000 for going value in case of a street railway company, the original cost less depreciation of whose property was $1,320,000.

(f) In the Chicago Railways case, the commission found that the amount of property destroyed in order to construct the new system of street railways adequate to the demands of a rapidly growing city amounted to $14,794,666.42; and that in determining the price to be paid by the city in event of purchase 10 per cent should be added to the physical cost as representing the cost of conducting construction. Both of these items were considered an element of going value, the amount of which was fixed at $20,000,000.

(g) In a case before the Missouri commission, 10 per cent was added to the cost of reproduction of a natural gas company's property to cover cost of all intangibles—including going value.

As many of the items making up "Going Value" are not capable of numerical expression, it follows that no formula can be devised from which such a value can be computed; and this notwithstanding the fact that it represents money devoted to the public use just as definitely as money paid for brick and other intangible items.

Therefore, it is not surprising that there is little uniformity in definition among valuation experts, either with respect to the accounting of going value or the methods by which it may be ascertained, and probably a good measure of this value may be had from a decision of the United States Supreme Court which named 10 per cent of the physical property of a natural gas utility to be going value as representing the added value of a plant as a whole over the sum of the values of its component parts, the going value being attached to the plant because it was in active and successful operation, earning a profit.

In another case, the Federal Court placed the going value of a gas utility at 12 per cent of the value of the physical property.

Need of Common Policy

In conclusion, it is easy to imagine that the interests of the natural gas industry would be materially advanced if some common policy could be adopted in regard to the inclusion of going value as an intangible asset in an appraisal of each company's properties. In the study of such a matter, all technicalities should be disregarded, for the reason that the problems of two gas companies operating in the same field may be quite different from a technical point of view. The fundamental basis of all claims before rate making bodies or government tax officials should be so formulated as to appear uniform for all natural gas utilities, each accordingly supporting the other in all important items likely to enter into consideration in rendering decision, rather than that the claims made by one company should in part damage the case of another concern. In effect, all are seeking the same end, i.e., a fair and proper allowance for our respective companies. Sometimes in our overzealousness, we unintentionally say or do things that prove a detriment to the entire industry. There is always ground for honest difference of opinion, but the best interests of the entire industry can be served only by those in proper positions being able to compare ideas. The question of rates and the proper rate base is the keystone of our business, since on it largely depends whether or not we shall be able to operate at a profit. Irrespective of reason or consequence, the public demand is ever for decreased rather than increased rates, although it should be recognized that there can be no normal development in any community where inadequate rates are impoverishing the public utilities so that they are unable to respond to the demands made upon them.

NATURAL GAS PIPE LINE READY TO GO INTO DITCH

Evolution in Pipe Line Construction

Problems of Transportation Held Back What Later Developed When Pipe Line Construction Opened the Way

By Walter L. McCloy
Vice President and General Manager, Muskingum Gas Producing Corp.

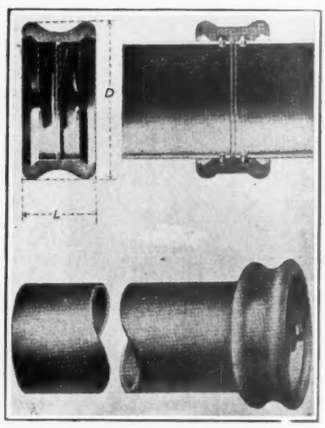
Present methods used in pipe line construction in the natural gas industry are not the result of preconceived ideas of engineers in the early days of the industry, but rather the result of evolution following the development from infancy to the enormous proportions of the industry of today.

It has been interesting to the writer and it may be to the reader, to follow the course of this evolution, the problems developed and how they were worked out, keeping in mind always that the pioneers trod an untraveled road and improved methods as new conditions confronted them.

Many wonder why the development of the natural gas industry was so slow in its earliest days when they know of its extraordinary growth later on. Thinking ones knew it was the problem of transportation that held back what later developed when pipe line construction opened the way.

First Pipe Line in 1824

The first recorded pipe line transporting natural gas for domestic use was laid in 1824, when gas was piped from a near-by well to an inn in Fredonia, N. Y., when the inn was illuminated with natural gas in honor of the visit of General Lafayette, while on his historic tour of the country at that time.



Converse lock joint pipe

The first industrial use recorded was in 1841 when William Thompkins piped natural gas from a well in the Great Kanawha Valley in West Virginia for use in heating salt furnaces. As early as 1859 natural gas was used in firing boilers and used for light and fuel in lease houses on oil properties in Pennsylvania, West Virginia and Ohio, but in all cases the gas was used quite near the point of production.

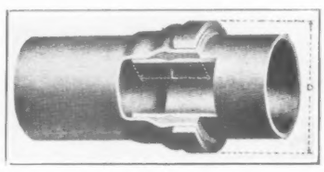
In 1872, a 2-inch line was laid from the Newton well to the city of Titusville, Pa., a distance of 5½ miles and gas was furnished for domestic purposes.

Oil operators in the early days considered gas a nuisance because there was no means at hand to transport to market their product. Manufacturers, however, saw the value of this wonderful fuel being wasted in the oil fields and in 1873 gas was piped to and used in a pottery in East Liverpool, Ohio, and in 1874, Rodgers and Burchfield piped gas to Leechburg, Pa., where it was used to heat their puddling and heating furnaces and under their boilers.

In 1875 Spang, Chalfant & Co. laid a 5⅝-inch line from a well near Saxonburg, Butler County, Pennsylvania, to their Etna mills near Pittsburgh, and it is interesting to note that thus far the industrial users piped their own gas from wells drilled by others to their own points of consumption. Capital soon saw that it was ridiculous for each large consumer to go into the field for his gas and corporations were organized to drill and transport the gas.

Gas Company Formed

In 1883, the Chartiers Valley Gas Co. was formed by prominent Pittsburgh manufacturers to transport gas from the old Hickory Field in Washington County, Pennsylvania, and from the Murraysville Field east of Pittsburgh to their mills and glass houses in Pittsburgh. In 1884, the Philadelphia Co., with George Westinghouse as its first president, was organized and began active operations in drilling for and transporting natural gas. The Acme Gas Co. was formed in 1885 and laid an 8-inch line from the Murraysville Field to the Carnegie Brothers mills at Braddock. Gas was piped from McKean County, Pennsylvania into Buffalo, N. Y., for industrial use, even earlier than this, and other instances could be named.



Matheson joint pipe

It can be readily seen that the beginning of real pipe line construction was made by the industrial users themselves, who later, combining their capital, were incorporated and sold gas for domestic purposes.

In the Pittsburgh district, The Peoples Natural Gas Co., The Equitable Gas Co. and The Manufacturers Light & Heat Co. are now the owners of most of the first "industrial" lines laid, and the Carnegie Natural Gas Co. is the sole survivor of the old days when the industrial user went afield for his gas.

Many of the earlier lines were laid of 5⅝-inch pipe and the reason for this was that in drilling wells at that time, that size of casing was then in general use and available from the mills. While the size appears to us now as small, yet it must be kept in mind that the first lines were not laid to supply a city, but to supply certain industries. When the public began to use natural gas, conditions changed so rapidly that real pipe line construction moved by leaps and bounds.

Big Change in Prices

To picture the change in conditions, I have before me an application for manufactured gas to the East End Gas Co. of Pittsburgh, dated 1876, in which the rate quoted is $2.65 per 1,000 cubic feet. One can readily conceive of the small volume handled and sold at that price.

Imagine the changed conditions a few years later when natural gas was offered at $1 per fire per month or a flat contract to supply all gas necessary to heat and light a residence for the period of one year. Imagine, if you will, iron and steel mills using gas at a rate based upon a ton of finished product and all other industrial consumers using gas at equally low and impractical rates. The answer was larger lines and more of them, and here we begin with the evolution of pipe line construction.

The only pipe suitable for the purpose known at that time, was screw pipe made in sizes up to and including 10 inches and cast iron pipe used by the manufactured gas and water companies.

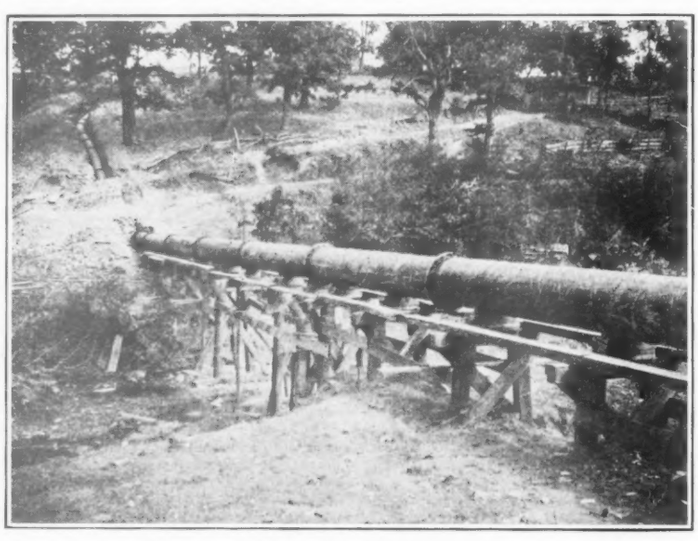
Cast iron pipe was used in city mains and in some cases in field lines up to and including 24-inch, but was unsatisfactory in field line use on account of its cost, weight and the expense in hauling and laying, but more particularly on account of its excessive leakage at high pressure.

To supply a pipe in sizes above 10 inches, E. C. Converse of the National Tube Co., developed the "Converse Lock Joint," which immediately jumped into favor.

The accompanying illustration will show the construction of this joint.

Lead Joint on Plain End Pipe

One side of the bowl was run with lead at the mill. It was laid in the same manner as cast iron spigot and bowl pipe, blocked with wooden blocks, bell holes dug and both sides of the bowl caulked in the ditch as laid. In this step of evolution, Mr. Converse used iron or steel pipe not threaded and simply developed a lead joint on plain end pipe. This was the beginning of the plain end pipe used today. The Pennsylvania Tube Co. developed a similar lead bowl for plain end pipe, but without the locking device shown in the Converse joint.



Line of 36-inch riveted pipe with flange joint

Here too was the beginning, so far as the writer can learn, of the use of "I.D." and "O.D." sizes of pipe used in the natural gas business, all screw pipe coming in "I. D." sizes and all plain end pipe in "O. D." sizes unless otherwise specified.

This advancement provided means for larger and more practical field lines, yet trouble was continually had with excessive leakage. Plain end pipe was accepted as practical, but the lead joint was still unsatisfactory for high pressure transportation lines on account of leakage.

Dresser Coupling Developed

All manners of clamps were experimented with and all sorts of gaskets used, but it was not until Solomon Dresser, the founder of the S. R. Dresser Manufacturing Co. of Bradford, Pa., developed a clamp using a rubber gasket that a practical clamp was developed. I quite well remember the first clamps used and the general comment that "the rubber would make a tight joint, but it will never last."

Gate valve on 36-inch line of Equitable Gas Co., south of Pittsburgh

This was in a way true with the rubber then used, but here again comes in the evolution of pipe line construction. It came through evolution in the compounding of rubber, resulting in a product meeting the requirements.

While we thought then our troubles were over with the use of clamps, we soon found that even with an improved clamp, a lead joint would still leak if moved by strain, settlement, or other causes.

It was quite evident that some joint must be developed to permit a certain amount of movement at the joint whether caused by expansion, contraction or other movement.

Mr. Dresser's successful use of rubber as gaskets in clamps offered a solution and he developed the Dresser Coupling. This was but a step from the Converse bowl using lead to a somewhat similar joint using rubber with end rings to compress rubber making the joint.

The first coupling line was laid in the fall of 1891, by Mr. Dresser, at Malta, Ohio, for the Malta & McConnelsville Gas Co., which he controlled. Five miles of 5⅝-inch line was laid and it is still in use.

The "old-timers" were very skeptical of this joint and to take care of the

Pipe Line Financing

Applications having been received in excess of the amount of issue, this advertisement appears as a matter of record only.

New Issue

$3,500,000

Rio Grande Valley Gas Company

First Mortgage 7% Gold Bonds

Series "A"

Dated April 1, 1927 Due April 1, 1937

New Issue

$2,500,000

Midwest Gas Company

First Mortgage 7% Gold Bonds

Series A

To be dated November 1, 1926 To mature November 1, 1936

Denominations of $1,000 and $500, registerable as to principal only. Interest payable May 1 and November 1, without deduction for Normal Federal Income Tax not exceeding 2%. Principal and interest payable in New York and Boston. Redeemable as a

As all of these bonds have been subscribed for, this advertisement appears only as a matter of record.

New Issue

$3,000,000

Southern Gas Company

First (Closed) Mortgage 6½% Sinking Fund Gold Bonds

With Detachable Stock Purchase Warrants

Dated November 1, 1925 Due November 1, 1935

Interest payable May 1 and November 1. Principal and interest payable in gold at First National Bank, Kansas City, Mo., Trustee. Interest is also payable at Guaranty Trust Company of New York, and at Continental & Commercial National Bank, Chicago. Coupon Bonds in denominations of $1,000 and $500, registerable as to principal. Redeemable at the option of the Company

THE foregoing represent some of our Gas Company underwritings.

We underwrite Bond Issues of Natural Gas Companies secured by mortgages on pipe lines and distributing systems.

We invite inquiries relating to such financing

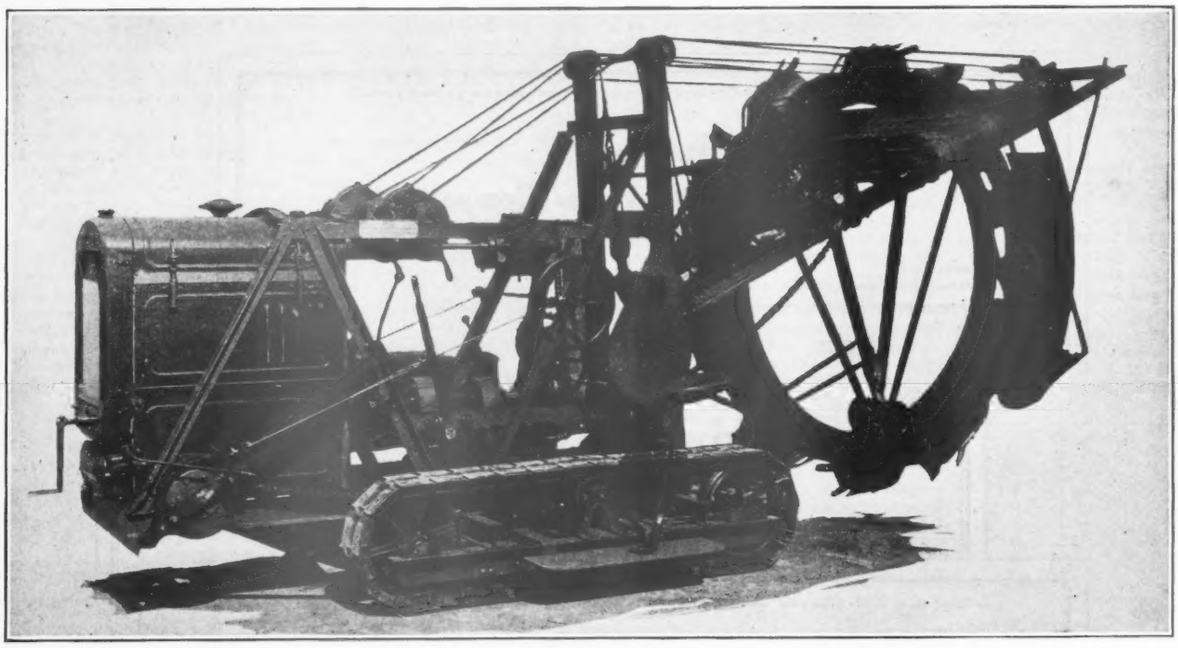
G. E. BARRETT & CO.

INCORPORATED

120 BROADWAY, NEW YORK

THE BABY DIGGER

REGISTERED



Compact Light and Powerful

Mobility Plus Real Digging Ability

DIGGING ITSELF INTO EVER-INCREASING FAVOR, WHEREVER PIPE IS LAID

If you are laying pipe this machine deserves a place in your equipment. A line from you will bring catalog and information as to where you can see a Baby Digger in action. No obligation, of course.

THE CLEVELAND TRENCHER COMPANY

"Pioneers of the Small Trencher"

20100 ST. CLAIR AVE. CLEVELAND, OHIO, U. S. A.

"middle of the road" officials, the National Tube Co. advanced the Matheson Joint shown in the accompanying illustration.

The Matheson Joint

To the lay members the Matheson Joint was simply a plain end pipe with a bowl similar to that used on cast iron pipe, which was expanded and rolled in the mill. A heavy band was shrunk around the end of the bowl to make more rigid when being caulked. It was claimed that this joint was an improvement on the Converse joint on account of there being only one lead joint to leak while with the Converse joint there were two. A special clamp and rubber were used and when first laid this joint made a satisfactory line. Movement of the pipe, particularly in high pressure transportation lines, however, caused leaks in same manner as in the Converse joint, but the leaks were less in number and not of as serious a character. We developed an eliptical rubber for this joint, which could be adjusted to suit the "break" in the joint, which proved quite successful.

This joint had advantages and disadvantages in laying. It carried a very small lead space which was an advantage in straight run lay, but a disadvantage when it was found necessary to "break" at a joint. To overcome this we used bent "pups" or short length joints. These bent "pups" were simply steel "specials" similar to those used in cast iron pipe line construction. These bends, however, suggested the bent pipe which was commonly used afterwards in laying large sized lines of plain end pipe with coupling joint; one thing suggesting another.

The Dresser Coupling and those of other manufacturers have also followed the evolution of development and the accurately pressed steel couplings of today are the results of many changes and improvements made from time to time.

Rough country no longer presented an obstacle to pipe line construction and 20-inch coupling lines were laid practically any place where such lines were necessary.

While the manufacturer was improving his product, the practical men in the construction work suggested and took hold of every practical improvement presented. The wooden trestles over sharp ravines were replaced with pipe supports with special saddles the lower end of the pipe supports being set in concrete.

Joints Were Riveted

This was first done to reduce the fire hazard. To accomplish this the one end of the pipe was expanded and the joints were riveted and caulked for such length as would carry over the ravines. Riveted pipe was also used in railroad crossings, where several lengths were required.

About this time welded fittings were obtainable and welded Y's, Tees and drip connections soon replaced cast iron fittings with their usual number of leaks.

"Van Stone Flanges" used in connections to gate valves was a practical step forward and riveted pipe on trestles and under railroads soon had a more practical successor in welded joints.

The use of the welded joint is the more recent step in the evolution of pipe line construction. Welded connections were first used in the natural gas industry, but welded pipe lines were first used to any great extent in oil pipe line construction. This was a natural step, however, because the welded joint was first offered as an improvement to the screw joint almost exclusively used in oil line construction. It has proven practical in sizes used thus far in oil line construction and the natural gas fraternity is interested in following results in the installation of the large diameter pipe line laid by the Magnolia Petroleum Co. in its line from the Monroe gas field of Louisiana to its refineries at Beaumont, Tex.

The largest high pressure natural gas transportation line known to the writer is a 36-inch line of the Equitable Gas Co. of Pittsburgh, Pa., extending south from that city a distance of 21½ miles.

PREPARING TO CROSS RIVER WITH GAS LINE

Punching holes in the rocky bed of river to blast a pathway for the 20-inch natural gas line being constructed.

It is constructed of one-quarter-inch plates, riveted and caulked in the same manner as in boilers, the joints coming in 12-foot and 24-foot lengths. The joints were made by using cast iron flanges riveted on the pipe and rope asbestos was used as gaskets. Cast iron angles of 2½ degrees, 5 degrees, 7½ degrees and 10 degrees were used in making bends and heavy wooden trestles were used to carry the line over ravines. Expansion joints of the bellows type were installed each 350 feet. The illustrations will more clearly show the construction.

This large line was laid with riveted pipe and flanged joints simply because no better substitute was known at that time. The writer had charge of the construction of the last 13 miles of this line and is grateful to the evolution in pipe line construction that it is no longer necessary to lay flanged joint pipe of large sizes over hill and dale.

Plain end pipe is now made in practically any size required and only recently there was completed by a large industrial concern operating in the Pittsburgh district, a 42-inch line of plain end pipe, laid with Dresser couplings for the transportation of by-product gas. This line is 10 miles in length and is laid parallel to a 40-inch line of similar construction.

The construction shown in the accompanying illustration is the last word in large pipe construction. These two lines, at relatively low pressure, have a carrying capacity of 200,000,000 cubic feet per day.

The average reader little realizes that the pipe lines in use by the natural gas industry total nearly 75,000 miles in length, which if connected together would encircle the earth about three times. Only a few stop to think that natural gas is now in use in 21 states of this country and that the number of consumers served exceeds 3,500,000. When one thinks of the enormous volume of 1,000,000,000,000 cubic feet of natural gas being transported by the pipe lines of the industry in 1926, and compares that quantity of natural gas with its equal heat value as bituminous coal, he will find that it will equal 35,000,000 tons of coal, which if transported by rail would require over 700,000 cars and would make up a train 6,000 miles long.

While evolution has developed and improved everything used in pipe line construction, yet each generation must produce anew the human element. No matter how good the material, no matter how efficient the joints, some good, practical, hard headed engineer or superintendent must select the route and locate safely where a line should be laid and his judgment has as much to do with practical "pipe lining" as the material itself.

A 48-inch pipe line in the Pittsburgh industrial district laid to transport by-product gas

Every Location of Well Is a Gamble

Considerations and Data Used by Executives in Selecting the Site for a Gas Well in the Appalachian Area

By John B. Corrin
Vice President and General Manager, Hope Natural Gas Co.

"Only the drill will tell!" Terse epigram, coined by the daring oil-seeking pioneer, it has ever remained truthful and worthy of all acceptance by those engaged in the great game of chance known as drilling for oil or gas. True, those seeking these minerals today have much for guidance not vouchsafed the pioneer in the famed and extensive Appalachian Field as, out of experience has been born and reared a wide knowledge of drilling conditions, an acquaintance with the study of numerous producing formations at various underground levels, each with its own peculiar conditions, including cave and water hazards and their casing requirements, and a familiarity with the minimum and maximum depths at which gas may be expected in the various localities. These and other guides point the way for the present-day explorer for nature's best fuel and yet that old adage of the oil fields still holds sway: "Only the drill will tell."

The bold explorer of the pioneer days sank his drilling bit at random, often giving no more thought to the selection of a drilling site than to use the spot on which a hat might alight after being tossed carelessly over the line fence. But, as time passed, his attention was attracted to the idea of using some method for selecting the location for the rig as false prophets arose in the land of oil seeking to beguile the unsuspecting and gullible explorer with glowing stories of the magic oil-finding power possessed by the forked branch of the peach tree wielded in expert fashion, or, by mysterious whispers, told of the doodelbug's seeming supernatural oil-smelling power. The vision of sure strikes for oil made possible by the peach tree and the bug made disciples among the early explorers but, sooner or later through bitter experience, most of the unwary came to renounce their faith in such agencies to again swear abiding allegiance to the drill, and it alone, as the true and only certain guide. And, lest the latter-day explorer adopt a mighty and holier-than-thou-attitude toward the easily deluded of the earlier days, it is well to remember that the exponents of the peach tree fork and of various other instruments, mechanical and otherwise, for locating oil and gas are still abroad in the land and not always do their golden-tongued utterances fall upon deaf ears.

Entrance of Geology

Then, along the trail leading to the mighty gasser, the flowing gusher, or the dry hole, came learned prophets—the geologists—to preach care in selection of the drilling site as they expounded their theories and taught the secrets of the underground. By these came knowledge and understanding of the anticline and the syncline with their important bearing upon oil and gas production. Fanatics have arisen in this as in other professions, it is true, who, having acquired some knowledge of geology and its influence upon oil and gas production, confidently offer to point out, for more or less princely compensation, the exact spot at which to drill for sure production of oil or gas, like unto the supremely confident geologist from the appropriate hamlet of Joker. Yet, so great has been the influence of the intelligent and conservative analyst of the underground strata upon the development of natural gas production, that these geologists now play an important role in selecting sites at which the drill shall start to bore on its long quest for underground wealth. Absolute reliance, however, cannot be placed upon geology, for despite the geologist's keen knowledge and analysis of the underground, he is often confounded in the Appalachian Field by the appearance of good gas wells at the bottom of synclines, contrary to his theory and teaching

Nor shall he who drills in the Appalachian Field place too much dependence upon the proximity of a large gas well in making his location for, although the existence of good gas wells is a factor wise to consider in making locations for gas, and while it is true that history records one large area of 50,000 acres giving birth to 800 gas wells and only one dry hole, too often has the operator found to his sorrow that a neighboring gas well of good volume is not a reliable guide but merely a tantalizing "will o' the wisp" and numerous instances are recorded of a detestable dry hole moving in to a reputable natural gas neighborhood and taking up its abode within 150 feet of splendid outstanding gas well neighbors.

Experience Good Teacher

True enough, the drill alone is the final arbiter in drilling for natural gas and yet, while every location is more or less a gamble, and no system has yet been devised whereby locations may be guaranteed to yield gas wells, experience is truly a good teacher in the gas drilling realm and, where operations have been fairly numerous, much has been learned by the experienced and studious explorer that serves as a fairly reliable guide and enables him to intelligently select locations where satisfactory results may reasonably be expected, equal at least to the prevailing odds in the Appalachian Field of two profitable wells to one non-paying well or dry hole. In undrilled or "wildcat" territory, the operator is dependent altogether upon the geologist or stakes the success or failure of the location upon chance, with convenience to roads, fuel and water alone determining where the location shall be made. But, in territory where operations have been conducted, the operator is not submissive to the changing mood of Dame Fortune, nor altogether dependent upon the skill of the geologist for knowledge of the underground formations, however skillful that advice may be. The wells that have gone before have blazed the trail in unmistakable fashion and if that most important requisite, a log or record of the drilling, has been kept, the operator has well-defined sand data to assist him in choosing the location site. While unfortunately true that haphazard records, or none at all, were kept of early wells in the Appalachian Field, the outstanding importance of accurate well logs for future guidance has long been recognized and extensive information about the underground sands in operated territory now constitutes important guide posts to the operator seeking his way to gas production.

The wise operator keeps a record of his own wells and, so far as possible, will acquire a knowledge of the sands encountered in wells of other operators so that, upon setting out to choose a location for a prospective gas well, this Blue Book well guide is consulted carefully to learn the number of sands which he may strike, the depth at which the drill should pierce each of these sands, the thickness and peculiarities of each sand, whether hard or soft, wet or dry, the prospective oil or gas production in each sand, the expectant life of this production, and the probable pressure of each sand. These are vital factors in choosing location sites and the prudent operator, not content with these guideposts in one or two wells in the territory where he would drill, makes comparison of this sand knowledge left by each well drilled over a broad area that this guidance may be thorough. In addition to the data already mentioned, it is important to learn whether the various sands likely to be encountered are of regular formation or spotted, and whether the sands run in long streaks or broaden out into pools.

Knowledge of Sands Vital

Knowledge, therefore, of sands to be encountered is of prime importance in selecting well locations and fortunate indeed is that operator who has built up a reliable library of well logs of his own and other operations. Still, the ghost of that old axiom, "only the drill will tell," is ever present for, although fortified by all possible knowledge of probable sands, the fond expectation of a gas well may not be realized, dry holes and dusters often being found where it was written in the sands, and proclaimed by many neighboring gas wells, that a gas well would be obtained, truly a famine in the midst of plenty.

Abundance of sand knowledge and the guidance of geologists are not the only requisites to intelligent and successful choice of gas well locations for, as the mariner depends not alone on the compass and the stars to steer his course but places equal reliance upon the charts, so that operator is again fortunate who has access to up-to-date, accurate and reliable maps, the importance of which in choosing well locations is generally recognized. The ordinary map information, such as towns, railroads, rivers and counties, while important, is far too meager when seeking a gas well location, and large operators build up an elaborate system of maps covering their extensive territories and operations. These maps, of large scale, often 4 inches to the mile, show not only the county but the district or township, every farm and its boundary lines, name and acreage of each farm, all creeks and rivers by name, every public highway, hamlet, village or city. To these maps much detailed information is constantly being added; the farms under lease to the operator owning the maps are accurately located and designated, all operations (gas and oil wells and dry holes) are spotted on the maps by various symbols, with the depth of the well, producing sand and initial production. To keep these maps up-to-date is absolutely essential, requiring a large staff of engineers, scouts and map men, but the large operator considers such maps indispensable to successful location and operation of wells, and a profitable investment. The small operator, too, well appreciates the importance of maps showing farms and operations when selecting his well locations and while his library may be limited necessarily in size and extent, he lays in store according to his resources, knowing that the intelligent choice of well locations is to a marked degree dependent upon the guidance of good maps.

Maps of Assistance

Maps are indeed of invaluable assistance in selecting the well location; the operator, like the general choosing a strategic point at which to make an assault, at once has before his eye a comprehensive view of the territory in which he is about to drill, all the wells from which the essential sand information must come are spread before his vision and, in addition, he obtains a quick grasp of the following other important determining factors:

Accessibility of location to water and fuel.

Location and bearing of adjoining farms and wells.

Spacing of well locations.

Intelligent location of wells demands that the selected site be accessible, so far as possible, to creek or river that ample water supply may be had for boiler and other uses in drilling; to roads that drilling material may be conveniently and economically moved to the location; to gas wells or lines that fuel may be conveniently obtained for boiler or gas engine power.

The wise choice of a location site also requires that the surrounding farm lines be carefully noted in order to obviate any justifiable demand for offset wells by adjoining farm owners. The prudent

Officials of Gas Companies Should Avoid Use of Poetry

If you think that the Natural Gas industry is without its "brighter" side, think again, for it can divulge tales equal to those which permeate the oil field bunkhouse, if one digs far enough for them.

It happened in Bartlesville, Okla., the first town in the State which was piped for gas. It has been reported that many individuals have been more or less piped for gas in that state, but undoubtedly Bartlesville was the first town.

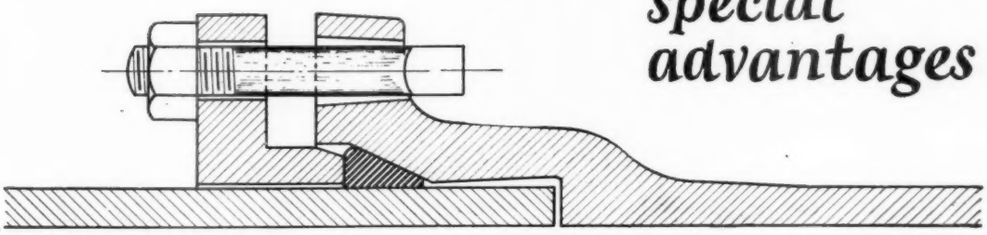
The gas company was appealing for a higher rate. The appeal was to be discussed in due time before the proper authorities, and while this was pending, the gas company decided to hold several public meetings with a thought to appeal to the fair-mindedness of the public.

As counsel, the gas company had a young man who was destined in later years to take a leading place in petroleum legislation, but for obvious reasons his name is withheld.

He was an excellent speaker. As counsel for the gas company, he detailed the numerous reasons why that long-suffering concern should be entitled to a higher rate of return upon its investment, and summing up he showed his vulnerable spot, for he resorted to poetry, and said "Remember the Light Brigade," and some wit in the rear of the hall shouted,

"Yes, and what a hell of a charge they made."

The Anthony High Pressure Joint and its special advantages



1. Requires one-half the usual number of gaskets.
2. Invariable Diameter—outside surface smooth—offering a perfect seat for the gasket.
3. Malleable iron bolts resist corrosion and eliminate self-electrolysis due to use of dissimilar metals.
4. Cast iron follower ring remains rigid and if for any reason gasket has to be removed the ring can be driven back without bending.
5. Changes and connections may be easily made using plain end pipe and an all cast iron coupling.

High pressure gas distribution is now accepted as good engineering practice and offers a material saving over a low pressure system. deLavaud centrifugal pipe equipped with the Anthony Joint gives a line of unusual flexibility, tight under the maximum pressures used in distribution.

Equipped with a lead or duck-tipped gasket these joints may be employed for either manufactured or natural gas.

If desired, deLavaud centrifugal pipe can be shipped in 24 foot lengths with a welded joint in the middle. Such an installation as this requires only 220 gaskets to the mile—one quarter of the usual number.

United States Cast Iron Pipe & Foundry Co.
Makers of deLavaud
Centrifugal Cast Iron Pipe

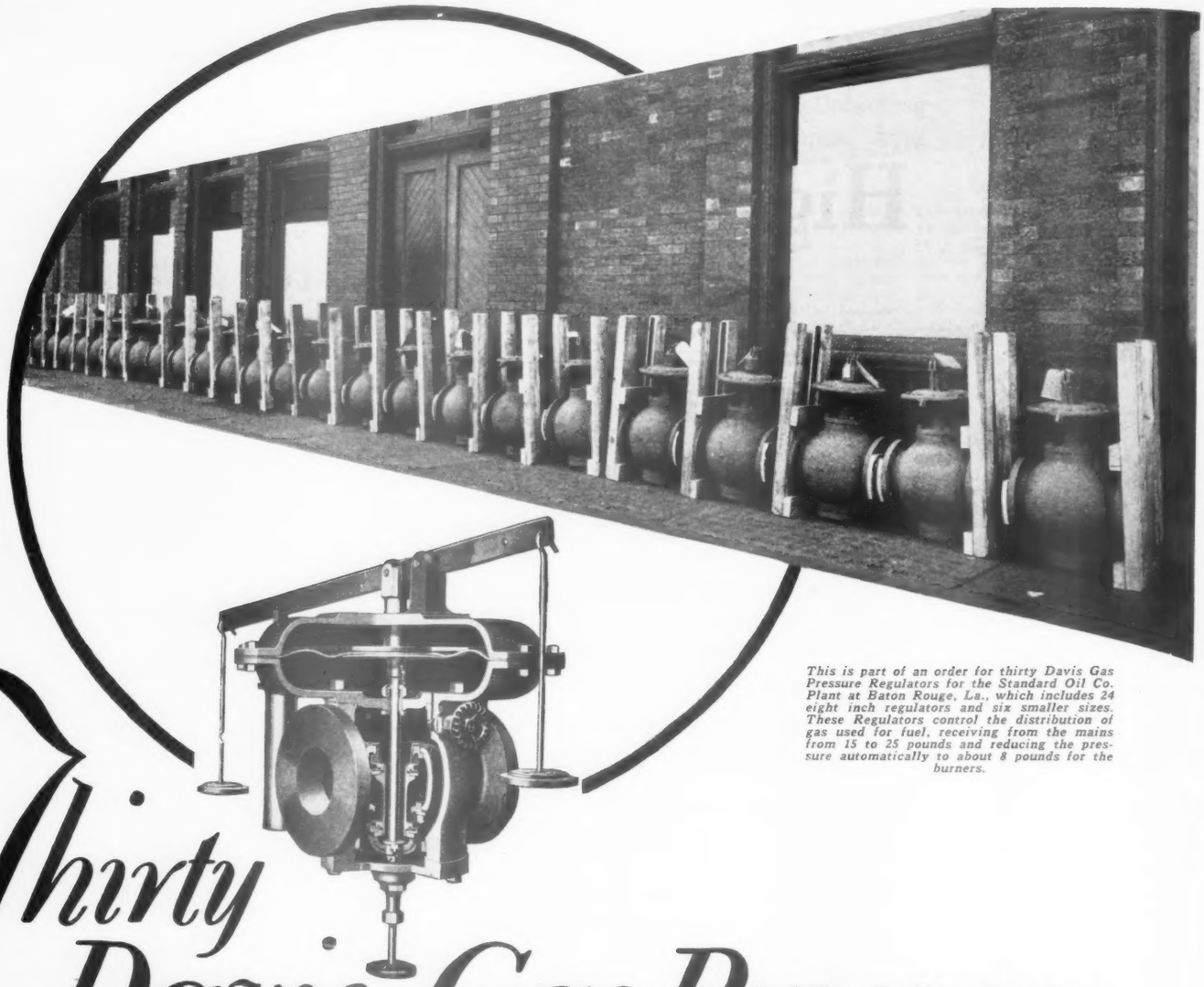
Write for descriptive literature covering the Anthony Joint and other special joints for gas service.

United States Cast Iron Pipe and Foundry Company

SALES OFFICES

Philadelphia: 1421 Chestnut St.
Chicago: 122 So. Michigan Blvd.
Birmingham: 1st Ave. & 20th St.
Buffalo: 957 East Ferry Street
Cleveland: 1150 East 26th St.
Minneapolis: 6th St. & Hennepin Ave.
New York: 71 Broadway
San Francisco: 3rd & Market Sts
Pittsburgh: 6th & Smithfield Sts
Dallas: Akard & Commerce Sts.
Kansas City: 13th & Locust Sts.

General Offices:
Burlington, New Jersey



This is part of an order for thirty Davis Gas Pressure Regulators for the Standard Oil Co. Plant at Baton Rouge, La., which includes 24 eight inch regulators and six smaller sizes. These Regulators control the distribution of gas used for fuel, receiving from the mains from 15 to 25 pounds and reducing the pressure automatically to about 8 pounds for the burners.

Thirty Davis Gas Pressure Regulators in one order

THIS shipment of thirty Davis Gas Pressure Regulators for the Standard Oil Co. Plant at Baton Rouge, La., is an effective demonstration of the approval which a great majority of distribution engineers give to Davis design and performance.

The Davis Improved Pressure Regulator handles any reductions in pressure accurately and dependably in hundreds of installations where the operating conditions are unusually severe. The service from these regulators is smooth and accurate under all the varying conditions found in day to day service. This regulator maintains constant delivery pressure even under the considerable fluctuation of initial pressures, and once the regulator is correctly adjusted for the desired delivery pressure, the entire control can be safely left to the automatic action of the Davis Regulator.

Davis Valve Specialties are all designed and built for the same high grade, dependable quality of service and for unusual accuracy. They are used by thousands of experienced engineers.

Send for catalogue and get the complete description of Davis design and operation. Davis Pressure Regulators are made in a full range of sizes and for pressures as specified.

G. M. DAVIS REGULATOR CO.
409 Milwaukee Avenue,
CHICAGO, ILLINOIS

WESTCOTT & GREIS, *Inc.*
Sales Engineers
TULSA LOS ANGELES DALLAS

DAVIS VALVE
ESTABLISHED 1875
SPECIALTIES

OGJ 6-16-Gray

gas well operator selects a site for the well at least 400 feet removed from the farm boundary, when possible so to do; he may hold the leaseholds on adjoining farms and, by drilling closer than 400 feet to farm boundary lines, invites troubles upon his head through demands for offsets by the adjoining farm owners even though the offending well proves to be a small producer. If the adjoining leaseholds are held by other operators, a location closer than 400 feet to the farm boundary, when possible to avoid such close contact, indicates scant respect for the rights of the fellow operator because of the almost certain demands for offset wells which such action precipitates. This disregard of the Golden Rule may terminate unprofitably for both operators; the offended operator may obey a natural impulse to drill as close to the boundary, or even a closer distance, than the offending operator, and thus the rule of proper spacing of wells is violated to the financial loss of both parties. Too often has this cut-throat policy prevailed in the past but a mutual respect for the rights of others has developed and while the crowding of lease lines is unfortunately not yet extinct, the practice is not as prevalent now, the large operators especially having come to realize the absolute folly of tramping the toes of the other operator, both from an economical and neighborly standpoint. The wise choice of locations should be guided by the "live and let live" policy, rather than disregarding the rights of others which latter policy invariably brings the three horsemen of retaliation, retribution and ruination riding hard upon the trail.

Spacing Most Important

Spacing of wells is most important in selection of locations, as has been indicated. One gas well to each 50 acres is considered sound and efficient drilling and intelligent location of wells will not violate the generally established and recognized rule that gas wells should be at least 1,200 feet apart. Crowding of lines, therefore, may not only disregard the rights of other operators, as pointed out, but imposes undue hardship in drilling expense on the operator who disregards the important factor of proper spacing in making his locations. On this feature too much emphasis cannot be laid. The mad scramble for gas wells a few years ago in the prolific and noteworthy McKeesport, Pa., Field of disastrous memory, where 900 wells were drilled in an area covering but 725 acres, proves the utter folly and suicidal policy of improperly spacing gas well locations. This factor again brings maps prominently to the fore, enabling the operator to study with wisdom and foresight the leasehold on which he would drill, and the surrounding operations, that he may not violate the essential factor of proper spacing with respect to existing wells and possible future locations.

Ownership in fee of various farms is advantageous within productive areas and the operator is fortunate whose selection of well locations is not dependent alone upon leaseholds of a limited term of years. Farm ownership is of material assistance in properly spacing locations; ownership assists in the economical planning of operations as the farm may then be drilled at will instead of being influenced by the expiring lease or the possible harrassing and oftimes embarrassing demand for operations which always hovers over the leaseholder; farm ownership also frees the operator from the carrying charges, or rentals, which the leasehold requires.

Drill to All Sands

Efficient choice of locations in a drilling campaign requires that the operator lay out certain defined areas on his maps in each of which one of the selected locations will be drilled to a depth sufficient for the drill to penetrate all known producing sands, whether or not former drilling has found these sands existing in that particular area. Often wells have been drilled to comparatively shallow sands in a defined area and nonproduction brought the "plugged and abandoned" penalty with consequent condemnation and abandonment of the leased area only to have the succeeding years flaunt the remorseful "might have been" wail by bringing forth splendid gas wells in the same area under the guidance of a more resourceful operator who, setting the "Go" signal where others had flashed "Stop," drilled deeper into the underground, opening a most prolific, extensive and remunerative gas producing area in a sand previously believed nonexistent in that particular area.

Intelligent and efficient locations for gas wells in the Appalachian Field is not a chance undertaking; it calls to assistance the science of geology, the keen analysists of that science, the extensive guidance written in the sands of the underground whose secrets have been laid bare when pierced by the drill seeking hidden treasure in other wells, and, like the mariner whose course is determined by close study of the charts, so the efficient pilot of gas well locations guides his course by a close study of the many guideposts placed with painstaking care on reliable and up-to-date maps. Yet, with all this knowledge and careful choice, ever and anon, instead of finding the safe gas well harbor, the location founders upon the dry hole shoal, while creaking rig, swishing cable and chugging engine seem to chant the old refrain: "Only the drill will tell!"

Deep Drilling in West Virginia

Extra Heavy and Staunch Equipment Necessary to Carry Hole Down About 1½ Miles

By A. L. Taylor and J. P. Davies

The subject of deep well drilling in West Virginia is very interesting and we have endeavored to outline the method of procedure from the selection of the site to the completion of the well.

In the selection of a proper site there are a number of important points to be considered, such as proper drainage from the well, water supply, roads over which material must be hauled, and sufficient space so that casing etc., may be handled easily.

An extra heavy rig must be built for a deep test and, if a wooden derrick is used, the best of hard lumber should be used for the derrick, with the legs and reinforcements made of white oak if possible. The derrick legs should be of 2-inch by 10-inch lumber, doubled, reinforced with 2-inch by 12-inch and 8-inch by 8-inch lumber bolted on the inside of the derrick legs. This makes an unusually stiff and strong derrick. The legs are set on a concrete base of sufficient strength to hold the enormous weight to which it is subjected.

Cellar Important Feature

Before the erection of the derrick, a cellar of suitable size, approximately 10 feet deep and 8 feet square should be built directly under the derrick floor. The floor of the cellar should be at least 3 feet thick. Heavy strings of pipe run in a well of this kind have to be clamped up and this is done in the cellar. The cellar is one of the most important features of a deep test well.

The derrick sills and all ground timbers must be unusually heavy to stand the extra heavy work required of a derrick of this kind. A seven sheave crown block is placed at the top so that the casing may be handled easily. The derrick is 90 feet high with a 24-foot base and a 6-foot top, insuring plenty of strength at the top; 7½-inch Imperial rig irons, with a 12-foot band wheel and extra large iron sand reel are used. Iron bull wheels with double tug and single brake may be used very efficiently until a depth of 4,000 feet is reached when we deem it practical to build a set of bull wheels with a shaft at least 24 inches in diameter, with four tugs on the tug side, and two 12-inch brake wheels, one on each end of the bull wheels, which gives equal braking power while running the tools in the hole at a great depth. Gudgeons should be of steel and 5 inches in diameter. All other parts of the wheels should be made extra heavy.

Tools and Machinery

As considerable steam is consumed in the drilling of a deep test well, it is advisable to set two 45 horsepower boilers, covering them with asbestos to conserve fuel. These are connected into one steam header to give a maximum head of steam at all times. It is advisable to use a 14-inch by 14-inch steam engine until a depth of 6,000 feet is reached, when a 16-inch by 16-inch steam engine should be substituted. When starting with a 20-inch hole, a 6-inch by 30-foot stem, with 6-inch joints, should be used. The 6-inch stem can also drill the 15½-inch hole and after running the 12½-inch casing, a 5½-inch by 35-foot stem with 4⅝-inch joint should be used. This stem can be used in the drilling of the 12-inch, 10-inch and 8-inch holes. After running the 6½-inch casing, 4½-inch stems with 4¼-inch joints are used on account of the thickness of the 6½-inch casing.

Drilling Cables

A drilling cable seven-eighths-inch by 4,000 feet is used to a depth of 4,000 feet at which time a cable 1-inch by 6,000 feet is put on. At a depth of 6,000 feet an 8,000-foot cable, tapered from 1⅛-inch to seven-eighths-inch is used, the lower 4,000 feet being seven-eighths-inch cable. When the seven-eighths-inch cable wears out, other seven-eighths-inch cable can be spliced on as required. The upper part of the cable is 1⅛-inch and will outwear several 4,000-foot lengths of the seven-eighths-inch, as most of its work is in the casing. We have found it more satisfactory to use a nine-sixteenths-inch sand line to a depth of 6,000 feet, at which time a five-eighths-inch sand line is used.

The best men obtainable, preferably those who have had experience in deep well drilling, should be secured. It is advisable to run three shifts of eight hours each instead of the customary 12 hour shifts, on account of the extra heavy work.

WELDING CASING

Casing

Below is a record of the casing used in the drilling of the deep well by the Reserve Gas Co., located on the Smith farm on Little Buffalo Creek, Union district, Harrison County, West Virginia, near Clarksburg. We consider this the most practical way to case a deep test well in this section.

Twenty-inch casing run to shut off surface water at 110 feet. Fifteen and one-quarter-inch casing run through salt sands at 1,010 feet.

Twelve and one-half-inch casing set on top of Injun Sand at 1,356 feet run to shut off Pencil Cave. This was D. B. X. casing weighing 50 pounds per foot.

Ten-inch casing run through Speechley sand at depth of 2,961 feet. This was D. B. X. seamless casing, weighing 54 pounds per foot.

Eight and one-quarter-inch casing set on lime shell, at depth of 5,043 feet. This was D. B. X. seamless casing, weighing 43 pounds per foot. This casing was run to shut off cave.

Six and one-half-inch casing run at a depth of 6,824 feet on lime shell. This was D. B. X. seamless casing weighing 32 pounds per foot.

We consider screw pipe preferable to welded pipe for an operation of this kind. All of the above strings of pipe were clamped up with rings and slips, which were placed in the cellar referred to above. We had considerable gas between the 10-inch and 12½-inch casing, which was taken care of by a bradenhead, the gas feeding into our lines during the drilling of the well from 2,961 feet down.

Caves, How Handled

When a bad cave is encountered and the well is at a sufficient depth to run a string of casing, it is advisable to do so, but if it is desired to drill deeper before casing, the cave can be taken care of by cementing, filling the hole up with two parts sand and one part cement, thoroughly mixed. This is put in the hole with a bailer specially designed for the purpose. After the cement has hardened (which usually takes about three days with quick-setting cement) a hole is drilled through, leaving a cement wall which serves as a liner.

Crooked Holes

We have had better success straightening up holes at our deep tests with Spiral Star Bits, which are made for different size holes. When drilling in sections where formations are slanting, crooked holes may be avoided by using these special star bits.

Fishing jobs on deep test wells are handled in about the same manner as on ordinary wells, the only difference being the greater depth.

The method of drilling as outlined above has been arrived at through our experience in drilling the following deep test wells:

Hope Natural Gas Co.'s well No. 4,190, Martha O. Goff, drilled to a depth of 7,386 feet, and abandoned after reaching this depth on account of running a liner to shut off cave. We now believe we could have shut this cave off with cement as outlined above.

Hope Natural Gas Co.'s well No. 4,304, I. H. Lake, drilled to a depth of 7,579 feet, and abandoned after reaching this depth on account of losing tools, caused by a cave. Believe this cave could have also been taken care of by cementing.

Hope Natural Gas Co.'s well No. 6,400, Joseph Gordon, near Terra Alta, W. Va., being in the range of Allegheny Mountains. Drilled to a depth of 4,800 feet and abandoned at this depth on account of slanting hole. We were troubled with a slanting hole from 1,200 feet down, and from 2,000 feet down with a very bad cave, most of which was shut off with cement.

Reserve Gas Co.'s well No. 918, L. L. Smith, drilled to a depth of 6,824 feet, at which point 6½-inch casing was run. Some trouble was encountered with the 6½-inch casing, and if it is remedied, well will be in good condition to continue drilling. This is the last of the deep tests, and it has been handled as outlined in this article.

Gas for Repressuring Old Oil Fields

Practice Rapidly Becoming of Great Importance. Use of Gas Increases Gravity and Lowers Viscosity of Oil

By H. G. Ellis
Division Manager, The Wiser Oil Co., Bartlesville, Okla.

Big Factor in Oil Industry

Government bureaus have estimated that only from 15 to 20 per cent of the oil in a sand is recovered by ordinary methods of production. Efforts to obtain a greater recovery and to bring to the surface at least a good part of that 80 to 85 per cent of the oil contained in the sand in old fields have developed the use of gas and air repressuring methods. Great success has attended these methods in widely separated sections of the United States. Mr. Ellis, author of this article, has been particularly successful in his operations in the oil fields in northeastern Oklahoma.

As he points out, the use of gas results in a higher gravity of the oil recovered, reduces the viscosity of the oil and had proved highly successful in increasing production of oil, instances being noted of a gain of 1,000 per cent in output of wells during repressuring.

The use of natural gas and air in repressuring the oil sand in fields where the gas in the sand has been depleted through years of operation is rapidly assuming a position of importance, especially to the oil producing branch of the petroleum industry. This phase of the business has not, as yet, developed any importance as a market for natural gas although the field presents some possibilities.

A large per cent of the repressuring plants now in operation are using air instead of natural gas for repressuring the sands. While the writer is aware that there are some authorities who maintain that air is equal, if not superior to gas for this work, there are some very important facts that do not support such a conclusion. However, the principal reason in most, if not all cases where air is used, is not because of the idea that air is the best medium, but is being used because an adequate supply of gas is not available, or if available it is at a prohibitive price.

Considering Air or Gas

While present cost should not of itself definitely control the method of operation, yet it does, and rightly should be a modifying element in the problem. The balance sheet covering the operation of the property until the last profitable barrel of oil from it has been marketed, should decide whether air or gas is to be used. As such a balance sheet will not be available until the completion of operation, a forecast of probable results has to be relied upon in making our decisions.

There are several elements to be taken into careful consideration in preparing a forecast of probable results from a repressuring project, among which in so far as it relates to the repressuring medium to be used, are the source of supply and its cost over the period of expected operation; the relative merits of the two mediums as affecting gravity and ultimate recovery of oil; its effect upon the fuel for operation of the lease and the value of the casinghead gas for gasoline recovery purposes; danger of corrosion, of explosive mixtures and many other items of lesser importance.

A careful survey should be made to determine whether or not an adequate supply of natural gas is economically available. The majority of the repressuring projects that are now in operation are on properties where vacuum has been, and in some cases still is maintained. This vacuum has contributed to the more complete exhaustion of the dissolved gases once contained in the oil. Most of the free gases have long since escaped, and very much more of the dissolved gas has been produced than would have been produced without vacuum.

Initial Cost Greatest

Old vacuum fields are comparatively rare that produce any considerable amount of casinghead gas more than enough for the operation of the property and for fuel for the employes after being stripped of its gasoline content. A few properties do have an excess of casinghead gas above reasonable operating requirements. If such excess gas be in any considerable amount the cumulative volume will, in time, go a long way toward meeting repressuring requirements.

Until the structure or sand body is saturated with gas there will, ordinarily, be more gas fed into the sand than is produced with the oil. However, the sand eventually will be filled, after which most of the gas compressed and delivered into the sand will later be returned through the producing wells to be collected and recompressed and started on another journey through the oil sand. This cycling of gas may be continued throughout the period of operation with such daily addition to the supply as would be required to offset the gas absorbed in the oil. Hence the initial daily average cost of gas used in repressuring a property will not remain the same throughout the period of pressure operation.

Start With Group of Wells

If the repressuring project covers a large block of leases and gas is available, but not available in sufficient quantities for the entire block, it is advisable to plan the compressor and pressure line installations so that the available gas may be delivered to a particular group of wells. As the available gas is increased by the gas returning with the oil, this group of wells may be increased. Even where air is used, with judicious operations, adequate back pressure on producing wells, and liquid sealing of sand the gas produced will not ordinarily, for many months after start of operation have a high air content, and may be segregated for use in another group of wells or may be mixed with pure gas. Should there be enough pure gas to justify the operation of a separate compressor or compressors, it would appear advisable to keep it uncontaminated. The presence of air always endangers oxidation and if a part of the wells could be saved from the danger it would justify the trouble, provided it did not cause too great an investment to do so.

Much Oil Left in Sand

For the properties on which there is no gas available for the repressuring work except through purchase, its utilization may be inadvisable. The cost of installing a gas line to the source of supply, plus the purchase price of the gas, would be in most cases prohibitive. It is regretable, however, that at least a portion of the excess gas from our gusher fields and their attendant gasoline plants cannot be transported to and made available for use in repressuring some of the depleted fields.

The amount of oil remaining in the sand after the economic limit of producing without the aid of some artificial method of bringing the oil to the well has been reached, must necessarily be relatively large. This is particularly true where the oil is contained in a closely-knit, fine-grained sandstone. An oil sand having a porosity of 12 to 20 per cent of voids is not at all uncommon. In such sands, capillary, surface tension and viscosity, hold the oil with grim tenacity. The power of the gas originally held in solution in the oil has been slowly expended in carrying oil to the well. So great is the force required to perform this work that the gas contained in a number of barrels of oil is required to bring each barrel to the well.

On one large group of wells in the Rogers Nowata fields of Oklahoma, where careful records have been kept over several years, and on which a vacuum of approximately 26 inches below atmospheric pressure was maintained, the average gas-oil ratio was 1,350 cubic feet of gas produced with each barrel of oil. Of this gas about 350 cubic feet came from evaporated oil induced by high vacuum. The barrel of oil produced, could not, under the pressure and temperature conditions there existing, contain more than a small fraction of this gas. Authorities who have made a careful study of the subject estimate that there is recovered from the average field, not more than 10 to 20 per cent of its oil content. Sand cores taken from old producing fields reveal oil in a surprising quantity remaining after years of producing.

Gas Pressure Not High

The average gas pressure in the sand in repressuring projects is not usually high. Probably an average of 75 pounds would not be exceeded in many instances. Under this pressure we may expect approximately 13 cubic feet of the gas such as is ordinarily available for repressuring to be dissolved in a barrel of oil of around 31 to 32 degrees Baume. Under the same conditions there will be approximately 3½ cubic feet of air dissolved in the same oil. While these figures will not hold true for all oils or all gases, but the ratio of absorbability is sufficiently accurate for the present purpose.

From experiments conducted by the Bureau of Mines, the absorption of 13 cubic feet of gas in a barrel of Oklahoma oil would cause approximately 5½ per cent reduction in the viscosity of the oil. Another test made on a California crude showed a decrease in viscosity of a little over 12 per cent; and with the same oil the absorption of 3 cubic feet of air caused an increase in viscosity of 10 per cent. Other tests have been made which showed no change in the viscosity of the oil when saturated with air, and yet other tests have resulted in a slightly reduced viscosity. When air is used the change in viscosity is probably due to oxidation.

Gas Increases Gravity

While the use of gas will almost invariably result in increased gravity and reduced viscosity, it is uncertain that the practice of stripping the casinghead gas of its gasoline content before returning it to the sand is advisable. Since the gas must be compressed to return it to the sand the additional processing to extract the gasoline adds only slightly to the cost of operation. But if the rich gas be returned to the sand, a greater amount of it will be absorbed in the oil, and the change of gravity and viscosity of the oil is proportional to the amount of gas absorbed. The ultimate amount and grade of oil produced might prove of more value than the gasoline that could have been extracted. Our tests on this phase of the work have not gone far enough to definitely determine the relative merits of the two procedures, but at the present price of natural gasoline, we strongly suspect it would be better to return the saturated gas to the sand.

As to the results that may be expected from the utilization of gas to repressure old oil pools, varying conditions lead to varying results. On one property an increase of 100 per cent in daily average production may be the maximum economically obtainable, while another property in the same vicinity may yield a daily production 10 times as great as that obtainable without the aid of the returned gas. Sand porosity, saturation, gravity and viscosity play important parts in the game.

Decline in Oil Production Due to Gas Exhaustion

It is generally conceded that the decline in oil production is in a much greater degree attributable to the exhaustion of the gas than of the exhaustion of the oil. In sands of the texture of the ordinary oil sands the power of capillary attraction is greater than the force of gravity when considered in relation to a fluid of the specific gravity and the viscosity of crude petroleum. As petroleum is a liquid solid it has no power of expansion other than through temperature changes, and therefore no power to propel itself through the sand to the well. This movement depends upon the expansion of the gases dissolved and entrained in the oil. The gas being exhausted there remains nothing to move the oil from its place in the sand pores.

The repressuring gas introduced into the sand through the pressure wells moved by the force of the following gas and by its own expansion as it travels from the pressure wells, acts as a propelling and carrying agent on the oil. If to this carrying power we add the reduced viscosity following the absorption of gas by the oil we start back toward original conditions when the reservoir was first tapped.

It is, of course, evident the original conditions can never again be attained, but much can be done toward partially restoring these conditions and the rewards will be in proportion thereto.

Sedimentary Cementing

An examination of a vertical cross section of the sand body reveals an almost constantly changing porosity throughout the entire thickness of the sand. This is partly due to the varying size of the sand grains, but more to sedimentary cementing. The gas following the course of least resistance naturally flows through the more porous sand, and in some cases leads to channelling of gas from the pressure well to one or more producing wells. This tendency usually may be overcome by adequate back pressures and by liquid sealing of the sand in the producing wells to which the channelling is directed. This back pressure also serves to cause the gas to penetrate the harder portions of the sand and com

"Credit Sentry of the Oil Fields"
Resources Exceed
$50,000,000

EXPERIENCE

It takes men of experience in the oil and gas business to direct the affairs of an oil and gas bank.

The directorate of The Exchange National Bank of Tulsa is composed of men who have lived the oil and gas business since those industries were in their infancy.

Many of them worked around the drilling wells in the oil and gas fields of Pennsylvania, Ohio, West Virginia, Indiana and Illinois and later became independent producers.

When the great Mid-Continent District was first opened they heard its call and followed the trend of the industry west.

Today these men who are nationally known as authorities on oil and gas direct the affairs of "The Oil Bank of America."

DIRECTORATE

E. W. SINCLAIR
J. H. EVANS
R. M. McFARLIN
J. J. LARKIN
DANA H. KELSEY
E. P. HARWELL
J. H. MARKHAM, JR.
JNO. Y. MURRY
J. J. McGRAW
H. F. SINCLAIR
J. A. HULL
J. A. CHAPMAN
H. H. ROGERS
W. A. BROWNLEE
H. G. BARNARD
GEO. S. BOLE
H. L. STANDEVEN

The EXCHANGE NATIONAL BANK

With which is Affiliated

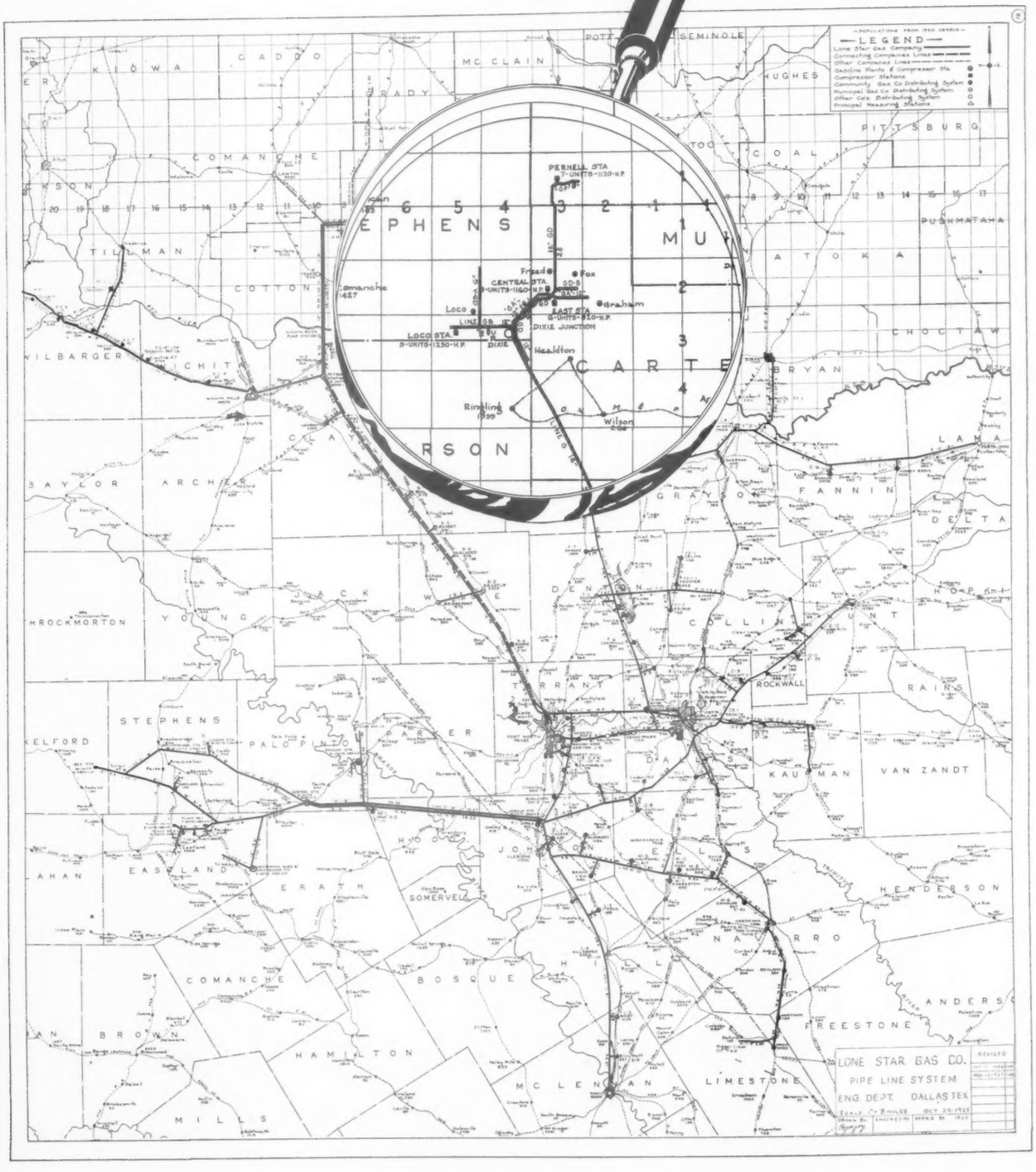
Exchange NATIONAL BANK TRUST COMPANY TULSA

The Exchange Trust Company

OKLAHOMA'S LARGEST BANK

You May Have to Use A Magnifying Glass

—BUT IT'S ALL HERE!



Lone Star Gas Co. Dallas, Texas

TEXAS' LARGEST DISTRIBUTORS OF NATURAL GAS

into contact with the oil contained therein.

Fear has been entertained that there might be a gas sand lying on top of the oil sand through which the gas might travel and not come into contact with the oil sand. If the so-called gas sand is continuous with the oil sand and not separated therefrom by some impervious formation it will be found that, after the gas has been exhausted therefrom, it will have practically the same saturation as the remaining portion of the sand. As the gas is exhausted capillary attraction draws the oil into the pore spaces so that there is no distinction between the original gas and oil-bearing portions of the sand. This fact has been checked again and again by coring and analyzing such sands.

If there be some impervious break between the oil sand and the gas sand the air must be confined to the oil sand. This probably will require drilling new holes for pressure wells and cementing off the gas sand. This will be necessary especially where the wells have been shot heavily or where the top of the sand has been shot so as to rupture the break between the two sands. Unless there is considerable back pressure maintained on the producing wells, the loss of the gas into the gas sand from the producing wells will not ordinarily be serious.

Conserving Output of Small Wells

Western Operators May Profit From Experience of Eastern Companies Where Little Producers Are Nursed Along

By Samuel W. Meals
President, Carnegie Natural Gas Co.

Natural gas has been utilized for light and heat in our country for over 100 years but I think I can safely say that it has only been in the past 10 or 12 years that the industry has placed itself on that sound financial basis where capital is wont to tarry. This has been brought about through regulation, consolidation, conservation and co-operation, and the three C's with proper regulation will tend largely to lengthen the life of the natural gas industry many years.

Anyone who lived within the area of the oil or gas fields in the early days knows something of the tremendous waste of this wonderful fuel—when to drill in a large well gave the operator much more concern than to drill in a duster, for the well had to be cared for, yet there was no market and in some parts of the western country this condition still exists. However, through regulation and from the fact that capital is better acquainted with the natural gas industry, this condition is gradually correcting itself. The operator is able to and in many cases compelled to mud off large gas wells. This has done much to conserve the gas reservoirs for future use. But the larger part of our wastefulness in the past was due to its cheapness—there being no facilities for marketing and no market established.

No Market for Product

The old Haymaker well in the Murraysville Field, within less than a dozen miles of the city of Pittsburgh, blew in the air for about two years before I. N. Pew built the 5-inch line to the city limits in 1883. In West Virginia many large gas wells were plugged and abandoned as no market could be found for the gas and it is only a few years back that if a well did not produce 1,000,000 feet per day it was counted in the duster list.

This condition in the gas industry was no different than other products where the marketing conditions do not warrant conserving. They tell me that when the orange crops in California were so bountiful and with low prices many growers had the oranges shaken off the trees to rot.

In the East this picture of the early gas industry is only a vision of the past, as the price has corrected these conditions largely. Operators are now drilling for 100,000 feet wells and many are saved if they produce one-tenth of this amount, and where the sands are free from water why should we not save the small well? A small stream is no value to a great hydro-electric power but the many small streams generate the power that lights up our cities or turns the wheels of industry. One gas well which will produce 20,000 feet in the line daily will supply 60 average consumers and 1,000 wells of this size will supply a city of 250,000 people and will give a fair return on the investment.

Low Average Per Well

One of the largest natural gas corporations in Pennsylvania has over 1,200 gas wells and the production per well per day for the past year averaged 19,000 feet. The Murraysville Field in Pennsylvania was the first area from which large volumes of gas were utilized and this field is still producing considerable natural gas, although pumps have been pulling a vacuum on the field for several years. There are gas wells in this field which produce more than 15,000 feet per day and have been producing for more than 30 years. A number of companies in the eastern fields have drilled 100 feet of pocket below the gas producing formation, that the water may drain out of the gas producing sand and the water bailed or pumped from the well.

At first glance, one may say it is too expensive to equip these small gas wells for pumping, "the most satisfactory method of removing the fluid," but if we figure the value of gas at the rate the public is justified in paying for this wonderful natural fuel, the gas operator should make every effort possible to maintain the flow from the many wells as long as possible. The production of oil in the eastern fields averages less than 1 bbl. a day per well, yet to produce this oil it is necessary to equip the well at an average cost of about $1,200 and on an average the well is pumped three days a week. Today a barrel of Pennsylvania grade of oil sells for about $3 per barrel or will give a gross return of $1,000 per year per well. A gas well that will produce 15,000 feet per day at 20 cents per 1,000 feet will give a gross return of $1,000 per year.

Draining and Removing Water

If more care had been taken in properly drilling, casing or cementing wells in the past, or properly plugging abandoned wells, a much larger recovery of gas would have resulted. Many old wells today may be restored or their volume increased by deepening for a pocket to trap the water and then pumped. Numbers of properties have been abandoned that not only would have given the public the use of Nature's fuel but the owner's larger returns on their investment, if this method had been followed and the water drained and removed from the sands. There are exceptions, but in either oil or gas producing fields, usually the head is off the first year and the larger and constant supply is produced from the settled production.

To the oil operator we give credit for the development of the natural gas industry, yet it is to the pioneer oil man we lay the blame for a large part of the tremendous waste of natural gas. What is known as wet or "casinghead" gas was permitted to flow in the air for years—only that needed for operating the oil property was utilized—so we cannot lay the full blame of this waste to the oil producers. They had no market and the gas companies had plenty of gas to meet their demands without going to the expense required to purchase and utilize the wet gas. However, as the gasoline demand came and the recovery of gasoline from the "wet" gas progressed, and due to compressing the gas for this recovery, the gas marketing companies were able to take the larger part of this surplus casinghead gas into their lines which helped to conserve the dry gas for the peak demands.

Lower Pressure Carried

The casinghead gasoline business in the eastern fields is gradually decreasing, but to offset this is the lower pressure carried on the field lines by the gas companies which permits the oil operator to better market the casinghead gas. Installation of small compressing plants on the oil properties to gather the casinghead gas as well as low rock pressure wells have been the means of recovering large volumes of gas.

To give some idea of the extent of this purchased gas from casinghead or oil properties, and from small independent producers in Pennsylvania, I am using records of one company only which supplies gas to a portion of the Pittsburgh district with a delivery of 22,000,000,000 feet last year. Over 12,000,000,000 feet was purchased from small individual operators. Only a few years back, a large part of the gas produced with oil wells had to blow in the air or make huge lights for the oil pumper's domain.

There is still too much of this precious fuel being wasted but with the advent of the oil recovery process of pumping gas into the oil-bearing sand to increase oil recovery, will do much to eliminate this needless waste.

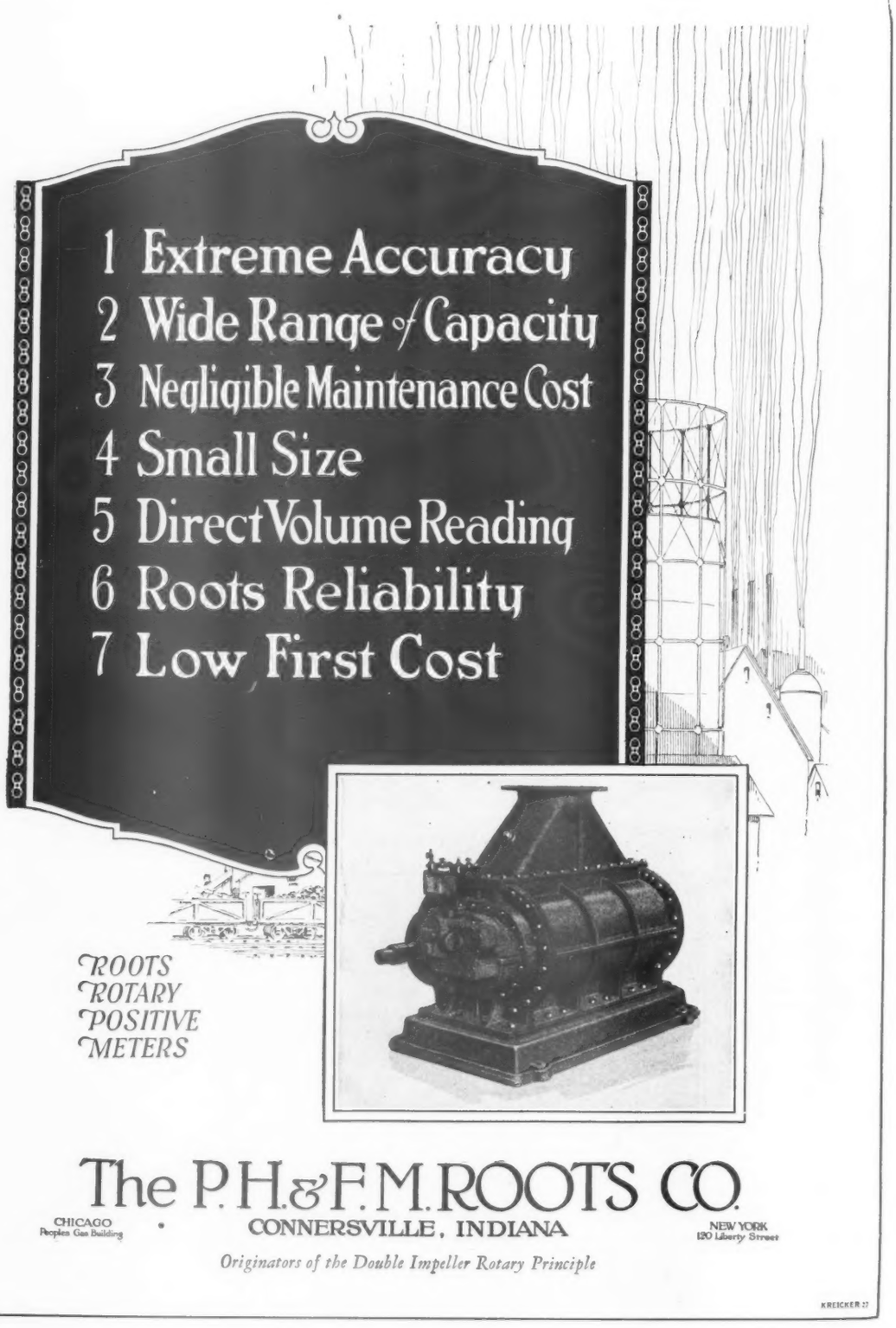
The attitude of the larger gas companies in purchasing and marketing this gas from the oil operator's properties has done more than any one thing to eliminate this waste.

There are some few localities in the East where gas is purchased and pumped from the pipe lines and stored in company wells during the summer months, that this extra supply may be at hand for the winter load. If our old wells are kept in shape, especially where one company owns the entire field, the storing of gas can be largely increased and will give the company the advantage of a better service to the consumer.

When the western operators are drilling wells which produce 50,000,000 to 150,000,000 feet per day, very little thought will be given to small wells, but with the many miles of new transmission lines that have been, are being and will be built, operators throughout the West should take time to consider the experience of the old eastern fields before running the plugs, for if the demand for the gas is not today, it may be tomorrow.

OXEN HAULING PIPE THROUGH SWAMP LAND IN LOUISIANA

It was first necessary to clear a space among the trees. The pipe was loaded on sleds or skids and drawn through the mud and water.



The P. H. & F. M. ROOTS CO.

CHICAGO
Peoples Gas Building

CONNERSVILLE, INDIANA

NEW YORK
120 Liberty Street

Originators of the Double Impeller Rotary Principle

KREICKER 27

Use of Natural Gas for Industries

Domestic Consumers Benefited by Lower Rates Made Possible Through Sales Which Help Pay Operating Costs

By A. Hurlburt*
Vice President, Equitable Gas Co.

Practically all natural gas companies have at some time been confronted with the question of cutting off or curtailing industrial consumers in order to take care of the domestic business. In fact, many gas companies have had this question put to them year after year and many natural gas men have themselves advocated this until a very great sales resistance against the selling of natural gas to an industrial market has been built up by the gas industry itself.

It is a certainty that there is just so much natural gas stored in the ground and the time is coming, and, in fact, has come in some places when manufactured gas must be added to the supply, and there are places where natural gas has been completely replaced by manufactured gas.

The sale of gas to manufacturers for industrial purposes is an economic question that the public does not realize and which many of the men in the gas industry have not analyzed. No one would think of asking an electric company to discontinue or curtail its industrial load, nor would anyone think of asking a manufactured gas company to do away with its industrial business, and today both of these utilities are adding daily to their industrial load. The natural gas industry must do the same if it is to survive and supply domestic consumers gas at reasonable rates. While the selling price per 1,000 cubic feet of gas to the industrial user is usually less than to the domestic user, in the manufactured gas business, or less per K.W. in the electric business, the return per dollar of investment is often more; this certainly is the case in the natural gas business, because, in general, the differential in rates between domestic consumers and industrial consumers is nowhere near as great as in the electric business.

Requires Less Investment

The industrial user of natural gas is generally a long hour, all-year load, and requires much less investment per unit sold than for gas sold for domestic purposes; the operating expenses per unit sold is lower than for domestic purposes. The load factor on the whole system is much improved by the industrial user, and it is just as necessary for him to have 100 per cent perfect service as for the domestic consumer, and unless the industry gives such service it cannot retain industrial business at rates that are satisfactory nor, indeed, can it retain a large amount of the business at all.

The cost of fuel to the industrial user is relatively a small part of his operating costs and, if the service is not perfect, the result in loss of production and spoiled product, the laying off of men and women because of lack of fuel to operate the plant, etc., more than offsets any saving that can be made by the use of gas. The industrial user cannot afford to substitute other fuel in his operations because in most cases he is an extremely efficient user of gas, and in order to be an efficient user his appliances are built for gas only and cannot be turned over to other fuels as a general thing. The industrial user is, therefore, a conservative user of natural gas and, if the average home owner used gas as efficiently, the demand would be very much less and we would not find such an ill assortment of ranges, water heaters and furnace installations in use as we now do.

It is the duty of all natural gas companies to give 100 per cent service to all consumers at all times and, if it cannot be done with natural gas, it should be done with the addition of manufactured gas. In fact, this giving of perfect service all the time must be the first principle of any utility serving the public.

In order that this may be accomplished, however, a proper spirit of cooperation on the part of the public, city officials and state officials is necessary in order that the utility may receive rates sufficient to enable it to give such service, because any other type of service is expensive at any price.

At this point it would be well to discuss some industrial installations of natural gas and then turn to the effect of these industrial uses to the general business and especially to the effect on the domestic consumer.

Gas in Ceramic Industry

The ceramic industry probably furnishes one of the most profitable fields for gas utilities that we have, and under this head would come the manufacture of abrasives, art pottery, cement, limeplaster, enamelware, glassware, heavy clay products, refractories, terra cotta and whitewares. Of course, this opens up an enormous field of operation, and the efficient application of fuel in the ceramic industries is the most important part of factory operation in these industries. The burning of pottery, the application of enamel and the melting of glass all involve complicated and difficult problems. It is only through careful study of the design and construction of furnace, the combustion system, furnace atmosphere and temperature regulation that low cost units can be obtained.

The question of heat is of great importance in the ceramic industry as the cost of fuel is from 10 to 25 per cent of the total cost of production in the majority of its branches. The principal use of gas is in the enamel, glass, heavy clay products, refractories, and whitewares division. Gas is the ideal fuel for such purposes because of its adaptability to accurate temperature and furnace atmosphere control which produces a more uniform and better ware, its cleanliness and ease of operation and because it has the least harmful effect upon the products or kiln in which it is being burned. Cheap fuel is a thing of the past. A gaseous fuel replacing liquid or solid fuel cannot be efficiently applied by merely the substitution of gas in the fire box or combustion chamber. A careful study of furnace design and operation is necessary.

Due to the constant demand, improving the general load factor, the gas load obtained in ceramic plants is of exceptional value to the gas company.

Enameling and Sanitary Ware

Vitreous enameling furnaces, for instance, operate as a rule, 24 hours per day and six days a week. An average sized furnace will consume about 1,000,000 cubic feet of gas per month. Figure 1 shows a gas-fired intermittent type gas-fired enameling furnace, interior and exterior views.

In the manufacture of sanitary ware, tunnel kilns operate at a steady demand per hour throughout the year, consuming approximately 10,000,000 cubic feet of gas per month for two kilns, as these are usually operated in pairs. These kilns are used for manufacturing closets, bowls and such sanitary ware, also for burning chinaware, brick, terra cotta, etc.

The tunnel kiln, a wonderful development in the ceramic industry, has shown fuel savings and advantages in the manufacture of many products such as porcelain insulators, vitreous china, porcelain table ware, plumbers' sanitary earthenware, fire brick and tiles, carborundum products, tank blocks, refractory blocks, common and face brick, paving brick, building and drain tile, terra cotta, carbon products, etc. The periodic type kiln, which is shown in Figure 2, is being replaced in many ceramic plants, because of lower maintenance and operating costs and improved ware produced, by the more efficient tunnel kiln. Figure 3 shows a continuous tunnel kiln. The material placed on cars slowly moves through the furnace, in which the temperature is automatically controlled, and is removed at the far end properly burned.

Porcelain enameling is described as the process of coating iron or steel with glass. The surface, differing from liquid enamel finish, is not affected by ordinary acids, will not fade or discolor and is a permanent coating, absolutely sanitary. Gas-fired furnaces have reduced the cost of enameling to such an extent that such ware is within the means of many more people. In most kitchens today, the sink, refrigerator, gas range, table top and utensils are all enameled. The cost of porcelain enameling has in one instance, by the use of gas-fired furnaces, been reduced from over $1 per 100 square feet to 20 cents per 100 square feet of ware.

Glass Manufacture

Gas is a very important factor in the manufacture of glass and glass products. A partial list of the glass products which are made in the Pittsburgh district includes sheet glass, plate glass, wired plate glass, decorative glass, tableware, ovenware, illuminating refractories and globes, lamp chimneys, auto lenses, glass lamps, door and furniture knobs, electric instrument covers, electrical insulators, tubing, jars and food containers, and bottles.

The methods and equipment used in making glass vary according to the kinds of glass and the product into which it is to be made, but practically all processes include the general operations of melting, forming, glazing or polishing, and annealing.

The melting of raw materials, glass sand or other silica material, an alkali flux and other ingredients for special characteristics, is carried out either in tank furnaces or in pot furnaces.

In production of bottles, plate and sheet glass and ware for which a large quantity of the same kind of glass is melted, tank furnaces are used. Figure 4 shows charging end of a continuous glass-melting furnace and is an installation for use of natural gas in the glass industry. Figure 5 illustrates typical burner arrangement of such a furnace. This furnace consumes 10,000 cubic feet of gas per hour, 24 hours per day.

Gas is used extensively in the manufacture of bottles and food containers for melting and annealing. The automatic bottle machine is used for blowing the molten glass into the desired form. Such a machine will produce 30 bottles per minute in various sizes. Glass is taken automatically in the molds from a revolving pot furnace, heated by gas, which has a circular hearth on which a shallow bath of molten glass is kept at a constant temperature. As the molds revolve the bottles are blown and shaped and cooled sufficiently to be dropped on to a conveyor that in many plants carries them to the annealing oven or lehr.

The lehr is from 4 to 6 feet wide and up to 70 feet long. Figure 6 is a front view of a six-section lehr, a long oven furnace in which the glass is heated to a temperature somewhat below the softening point and cooled by passing through successive zones of gradually lowering temperature. This is a continuous operation, important in lowering the cost of production.

Fuel Consumption and Efficiency

Glass melting, a high-temperature operation, is not an efficient process. The thermal efficiency of a regenerative tank furnace has been estimated and computed as being from 10 to 15 per cent. Non-regenerative tank and pot furnaces utilize an even smaller percentage of the heat in the fuel. Radiation of heat from furnace walls and heat carried away by hot stack gases are the principal sources of heat loss. Improvements in firing and operating are being made, however, and must be given careful study and attention if natural gas is to continue in the glass industry at rates now generally in force. The following table shows the hourly consumption of natural gas for

Best Fuel for Many Industries

The sale of natural gas to manufacturers for industrial purposes is an economic question little comprehended by the public and which many in the natural gas industry have not analyzed.

The industrial user is generally a long-hour, all-year load and requires much less investment per unit sold than for gas sold for domestic purposes and the operating expense per unit is lower than for domestic purposes.

There are many manufacturers whose operations are such as require a steady, constant heat, easily controlled and for these, natural gas forms an ideal fuel. Among such concerns may be listed the ceramic industry, makers of sanitary ware, glass manufacturers, the metallurgical industry, forging, annealing, hardening, tempering and other uses in the heat treating field; foundries, die casting, melting metals, brass making, galvanizing industry, bakeries, and thousands of other purposes for which gas can be sold in smaller shops and plants.

Without an industrial business, the charges for operating and investment of the gas company would be nearly as high as for supplying only the domestic consumers and all this expense would have to be carried by the domestic consumer, necessitating higher rates for gas.

*To R. E. Polk, superintendent of industrial and commercial gas sales, Equitable Gas Co., is due credit for furnishing much of the material contained in this article

Uses of Natural Gas in Industry

1

Enameling Furnace

2

Tunnel type Ceramic kiln showing method of firing

3

Gas fired continuous Tunnel Kiln

4

Installation for use of Natural Gas in Glass Industry. Charging end of Continuous Furnace

5

Further arrangement of Glass melting Furnace

6

Glass lehrs - Gas fired

7

right
Annealing Furnace equiped with nozzle mixing Natural Gas Burners

8

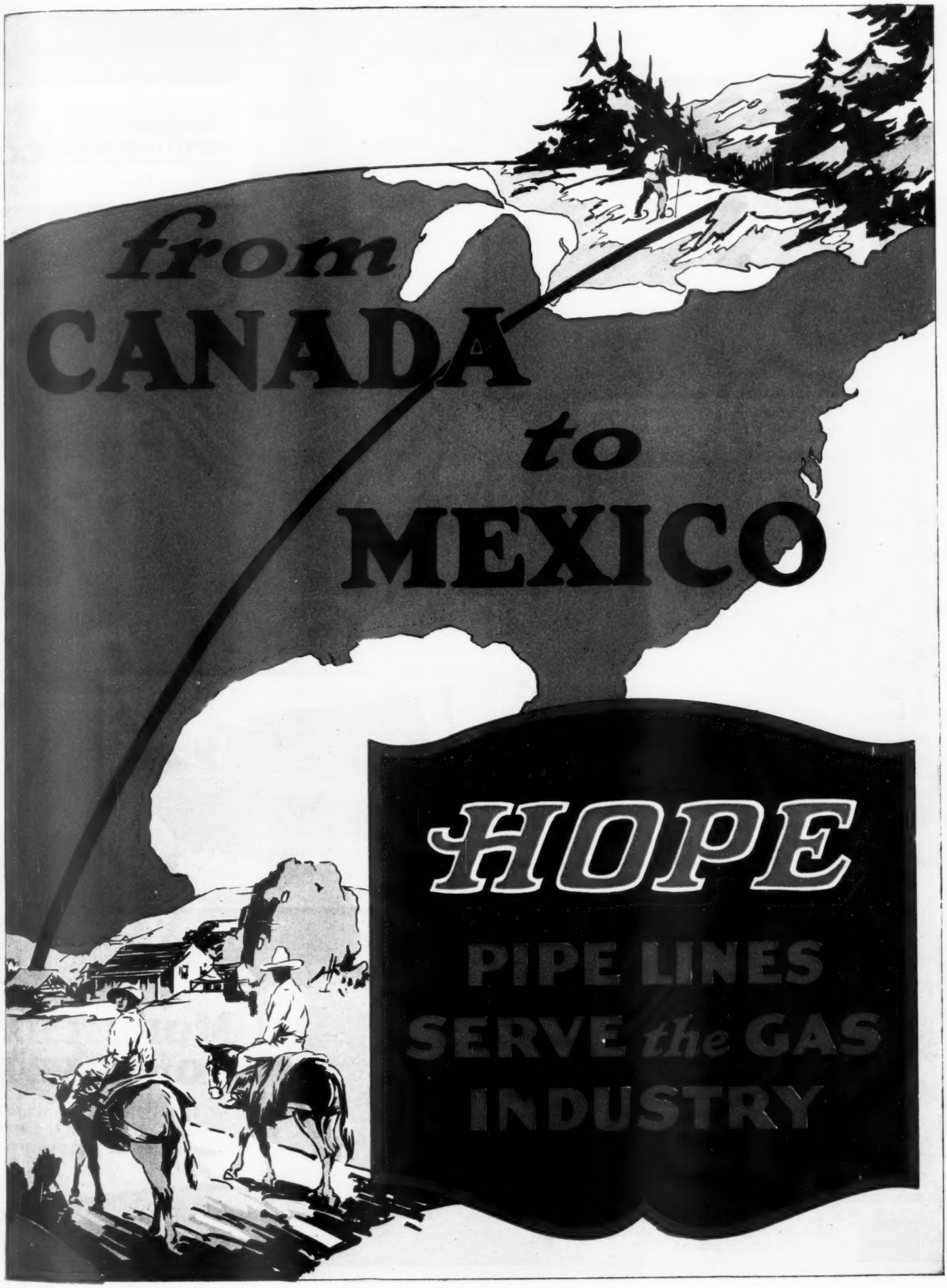
Quench and Draw Furnaces

9

Gas fired Furnace for reheating alloy steel ingots

10

Surface combustion sheet annealing Furnace


from
CANADA
to
MEXICO
HOPE
PIPE LINES
SERVE the GAS
INDUSTRY

Nature offers no obstacles which Hope resourcefulness cannot surmount.

River crossings offer special problems which Hope engineers know how to solve.

Pipe line construction through marsh and forest is all in the day's work.

Hope schedules are kept, even where the right of way is through boggy ground.

ENGINEERS
CONTRACTORS
H
ENGINE
CO
MOUNT V
DALLAS, TEX

WA SHINGTON
OREGON
MONTANA
NORTH DAK
SOUTH DAK
WYOMING
NEBRAS
NEVADA
UTAH
COLORADO
KAN
ARIZONA
NEW MEXICO
COAHUILA
ZACATECAS
SAN LUIS POTO

MORE THAN 3
OF HOPE-BUILT

In all the important fields, t tify
Hope Company in the world pipe
wide in scope and preparedne Hop
satisfy.

HOPE ENGINEERING AND SUPPLY COMPANY
DESIGNERS MANUFACTURERS
OHIO, U.S.A.
OKLA. CASPER, WYO.

Some notable Hope records have been made in the dead of winter.

In all weathers, in all seasons, a Hope pipe line job keeps to its schedule.

Over mountain and desert, Hope-built pipe lines make their way—on time.

Long distances from sources of supply are no obstacle in Hope progress.

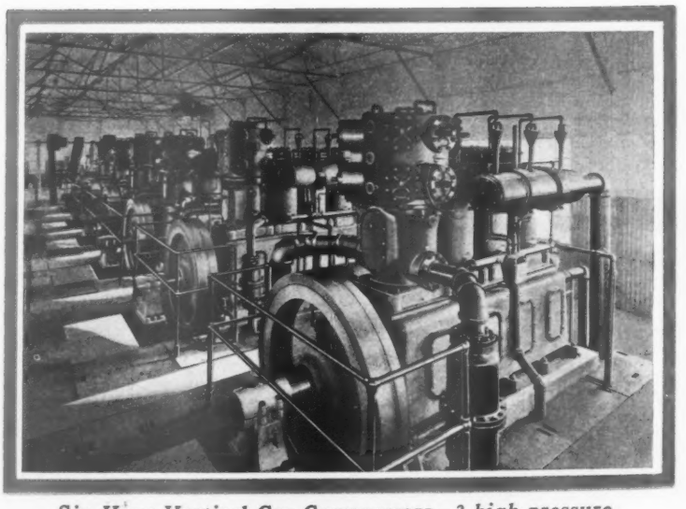
AN 3000 MILES
BUILT PIPE LINES

tify to the supremacy of the pipe line construction. Nation-Hope Service has never failed to

Organized—Experienced Responsible

WITH an experience of 21 years and with a record of achievement without an equal, the Hope Company is preeminently qualified, equipped and ready to execute any project in pipe line construction, anywhere.

Showing 20 of the 36 Hope Vertical Gas Compressors owned by the Houston Gulf Gas Company.



Six Hope Vertical Gas Compressors—3 high-pressure, 3 low-pressure—in a plant of the Marland Refining Company.

glass house use, representing actual practice in the Pittsburgh factories:

	cu. ft. per hr.
150 ton tank (26 ton daily output)	8,000
450 ton tank	28,000
5 ton day tank	2,500
5'x12' day tank	1,700
5'x16' day tank	2,500
14 pot furnace	7,500
12 pot furnace 1,700	5,400
11 pot furnace	4,500
Glory hole 600	1,000
Polishing torch 200	500
Pot arch 500	1,500

Gas in Metallurgical Field

All heat operations in the manufacture of steel and steel products and in the treatment of metal are being done with gas. These include open hearth furnace melting, forging, normalizing, annealing, hardening, tempering, carbonizing, etc. The advantages previously mentioned, together with the lower insurance rates due to the elimination of large coal or oil storage, make gas the ideal fuel for metallurgical purposes, and it is used to a large extent in the Pittsburgh district.

A comparison of the cost of natural gas and fuel oil for steel melting will show savings through the use of gas. The average consumption per ton of steel melted is 5,000 cubic feet of 1,100 B.t.u. gas at 50 cents per 1,000 cubic feet, or $2.50. Oil consumption averages 40 gallons per ton of steel melted, which, at 6½ cents per gallon burned, costs $2.60. In addition the refractory life is longer with the use of gas, thus reducing lost furnace hours and maintenance costs. Although natural gas is still being used as open hearth fuel in a number of instances, the volume of sales for such use is gradually decreasing as the price of the gas necessarily increases to a point where the large steel mill finds it profitable to use a solid fuel or their own gas, which is a by-product of their coke operations.

The many uses of gas in the treatment of metal are well known. The trend of industry toward the use of automatic equipment for heat treating operations is realized and gas, because of its adaptability to automatic operations, is being used extensively. One plant, for instance, has recently installed 24 continuous gas-fired furnaces for normalizing, hardening, drawing, billet heating; automatic machines with one operator replaces eight furnaces and eight men previously required for the work.

When it is known that the furnaces referred to consume, in one plant, almost 2,000,000 cubic feet of gas per day, with proposed additions that will about double that amount, the opportunities in the metallurgical field for gas are readily recognized. Such business is not obtained, however, unless the proper utilization equipment and rates are made available to the customer.

Heat Treating Field

For forging, annealing, hardening, tempering, and all uses in the heat treating field, the ease of application, high thermal efficiency and general convenience characteristic of gas apply in full force. Authorities agree that surface oxidation, decarbonization and carbonization are under better control where gas is the fuel than in any other case. The ease with which uniform temperatures and furnace atmospheres can be maintained using gas as a fuel makes it very desirable for heat treating purposes.

Furnaces of various types are used for heat treating work. The difference in operation of these types is in the uniformity with which the material is heated. Correct operation of the furnace, as to uniformity of temperature in the working space and loading and heating of the material to be treated are important factors. Furnace atmosphere is a very important consideration in all heat treating operations and in the gas furnace is always under control. Through adjustment of gas and air fixed conditions can be maintained and the work is produced with the best possible finish, a principal advantage of gas-fired furnaces. Proper temperature measurement is also very important, because a few degrees error in the furnace temperature may mean all the difference between success and failure.

Figure 7 shows an annealing furnace equipped with nozzle mixing burners. 20,000 pounds of alloy steel forgings and die blocks can be normalized (1,700 degrees Fahrenheit) on gas consumption of 3,200 cubic feet per hour.

Eight sections of tempering furnace are shown in Figure 8. The maximum capacity per door is 5,000 pounds and maximum gas consumption per door, 900 cubic feet per hour. Each section is underfired with one nozzle mixing gas burner. The range is from 600 degrees Fahrenheit draw temperature to 1,800 degrees Fahrenheit quenching temperature.

Figure 9 illustrates a 10 by 8-foot by 52-inch forge furnace used for reheating alloy steel ingots for hydraulic press work, two 14,400-pound ingots can be heated from cold start at 2,250 degrees Fahrenheit in 24 hours with gas consumption of 4,200 cubic feet per hour or 4.75 cubic feet per pound.

An annealing furnace used for blue annealing of sheets is shown in Figure 10. This operation gives the best possible load factor as it operates 24 hours a day, 365 days a year. Production is 100 tons of 10-16 gauge single sheets on a gas consumption of 3,000 cubic feet per ton.

Figure 11 shows a bright annealing furnace for annealing nickel sheets. This furnace is 170 feet long, including cooling chamber. Production of 100 tons per day of 24-inch and 48-inch sheets. Furnace operates 24 hours per day.

Figure 12 shows tie plate reheating furnace. This furnace heats steel bars to a temperature of 1,300-1,400 degrees Fahrenheit for hot punch and sheer work and 400 tie plates per hour are made on a gas consumption of 7,200 cubic feet or 18 cubic feet per plate. A low-pressure, single valve control system of burners makes it possible to keep the furnace atmosphere slightly reducing at all stages of turn-up or turn-down and thus cut the scale to a minimum.

Figure 13 illustrates another type of furnace for heating large billets to a forging temperature. Two tests run on this furnace, equipped with a Calco recuperator, follow:

Test No. 1 (Drill collars)—	Time
Charged Monday	4:00 p.m.
Started forg. Tuesday	8:30 a.m.
Tuesday	11:30 a.m.
Finished Tuesday	3:00 p.m.

(3.7 cubic feet gas per pound of steel.)

Test No. 2 (Bits)—				
Charged Thursday	4:00 p.m.	5	8"x 8"x 8'	8,670	25,769
Started forg. Friday	8:30 a.m.	5	8"x 8"x 8'	8,670	13,900
Re-charged Friday	11:30 a.m.	1	8"x 8"x 8'	1,700	8,189
Total				10,370	47,858

(4.6 cubic feet gas per pound of steel.)

One of the most efficient types of gas furnaces is illustrated in Figure 14. This is a rotary carbonizing process using raw gas in the retort as a carbonizing medium, eliminating packing of material to be case hardened in some carbonizing compound. Gas is also used for heating the retort in which the material is loaded. Three hundred pounds of chain link pins are carbonized to a depth of three-sixty-fourth-inch in 1¾ hours on a gas consumption of 1.3 cubic feet per pound.

The 41-horsepower low-pressure steam boiler is used for heating pickling tanks to pickle steel hinge stock, before the cold rolling process. Gas consumption is 1,736 cubic feet per hour, at 50 cents per 1,000, or 88 cents. The unit cost per gallon of solution raised from 40 degrees Fahrenheit to 180 degrees Fahrenheit is .008 cent. Eleven gallons per hour are raised from 40 degrees Fahrenheit to 180 degrees Fahrenheit for 1 cent.

For those who want to obtain business which will provide a steady load and long hour consumption, the electro plating and allied industries is a fertile field. Heat is needed in the majority of operations involved and although the gas consumption may not be great, they are steady and for long hour factors are not to be ignored.

Non Ferrous Metal Industry

Gas is not new in the foundry business. For the melting of metals gas has repeatedly proved successful and manufacturers who have depended upon solid or liquid fuel and suffered loss of time and increased cost from spoiled work appreciate the advantage of eliminating that waste. Improvements in gas furnaces have been made and extensive research work is now being carried on to develop more efficient equipment. The extent of the field open to gas is shown by the fact that over 80 per cent of the brass foundries in the United States use coal and coke. The character of the product, casting or ingot, and its cost are directly dependent on the fuel and furnace used.

Each foundry or casting shop is a distinct problem in itself. In fact, every industrial job has certain characteristics peculiar to itself which must be studied and analyzed. Plants do not deal with the same alloys or carry on the same work. Conditions vary widely in different locations. Manufacturers cannot afford, however, to overlook the advantages of gas as a fuel from an economic standpoint. One particular industry owes a large part of its success to the use of gas. Die casting was unknown commercially before the heating problems were solved and developed by the industrial gas men. There has never been a practical commercial application of die casting worked out with any of the crude fuels.

Advantages of Gas

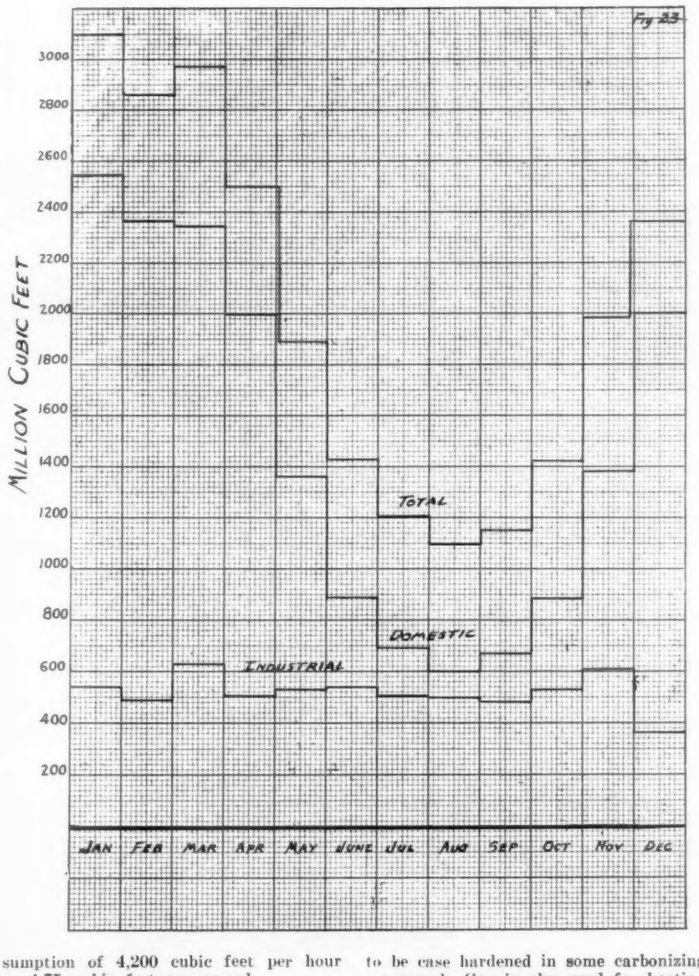
Advantages of gas to be considered in comparison with other fuels for melting metals are:

1. Lowest oxidation.
2. Lowest melting cost per pound.
3. Shrinkage loss decreased due to ease of manipulation and regulation.
4. High quality of finished product.
5. No oxidation while furnace is held on account of delays, or while being emptied.
6. Gives more heat per crucible, in that type of furnace, than any other fuel.
7. Is very rapid, saves time and increase output of furnace per day.
8. No storage or labor cost of handling. In case of oil added power cost for pumping, maintenance of pumps and loss of time through the carbonization of oil and stoppage of oil pipes and burners.
9. Meets all insurance requirements.
10. No money invested in fuels in stock.
11. Extremely small initial investment for equipment.

Excels in Brass Melting

In the melting of brass gas cannot be excelled. It is well known that variation in composition of brass is due to oxidation and volitalization. When gas is used, stratification of furnace gases which subjects the melt to oxidizing conditions, is avoided; little consumption of fuel occurs in the heating up of the furnace; the temperature can be controlled; no fuel or ash handling. Exact regulation cannot be attained with solid fuel and the loss of metal due to volitalization is very important. Using fuel oil is a more complicated problem, because to be successfully burned, oil must be atomized and gasified. For efficient combustion this process requires time, large combustion space and low velocity of gasified oil and air. It is practically impossible to operate an oil furnace with a reducing flame on account of the excessive amount of air that must be forced into the furnace to increase the speed. Oil and air pressures usually fluctuate,

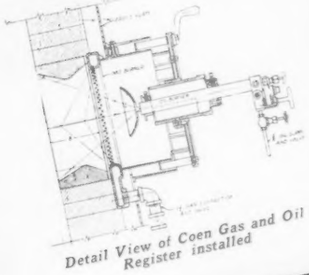
TOTAL SALES, DOMESTIC SALES, INDUSTRIAL SALES FOR 1926



at one of the world's largest refineries !

834 Coen fires installed by Standard Oil Co. AT Baton Rouge

Side View of Coen Combination Firing Set for gas and oil



Detail View of Coen Gas and Oil Register installed

The largest group installation of burners ever installed has just been completed at the Baton Rouge refinery of the Standard Oil Company. This installation includes 834 Coen Combination Gas and Oil Burners. Every fire, from the blacksmith forge to the giant stills, is Coen-equipped—an outstanding recognition and tribute to Coen efficiency. Before making this choice Engineers made exhaustive study and tests of every type of burner.

Thousands of other plants are also profiting by the use of Coen Burners.

As specialists in combustion devices, we devote our entire effort to the manufacture of Gas and Oil Burners and supplementary equipment—for all purposes.

For Industrial Furnaces.

Mechanical Oil Burners — Gas Burners

Combination Oil and Gas Burners

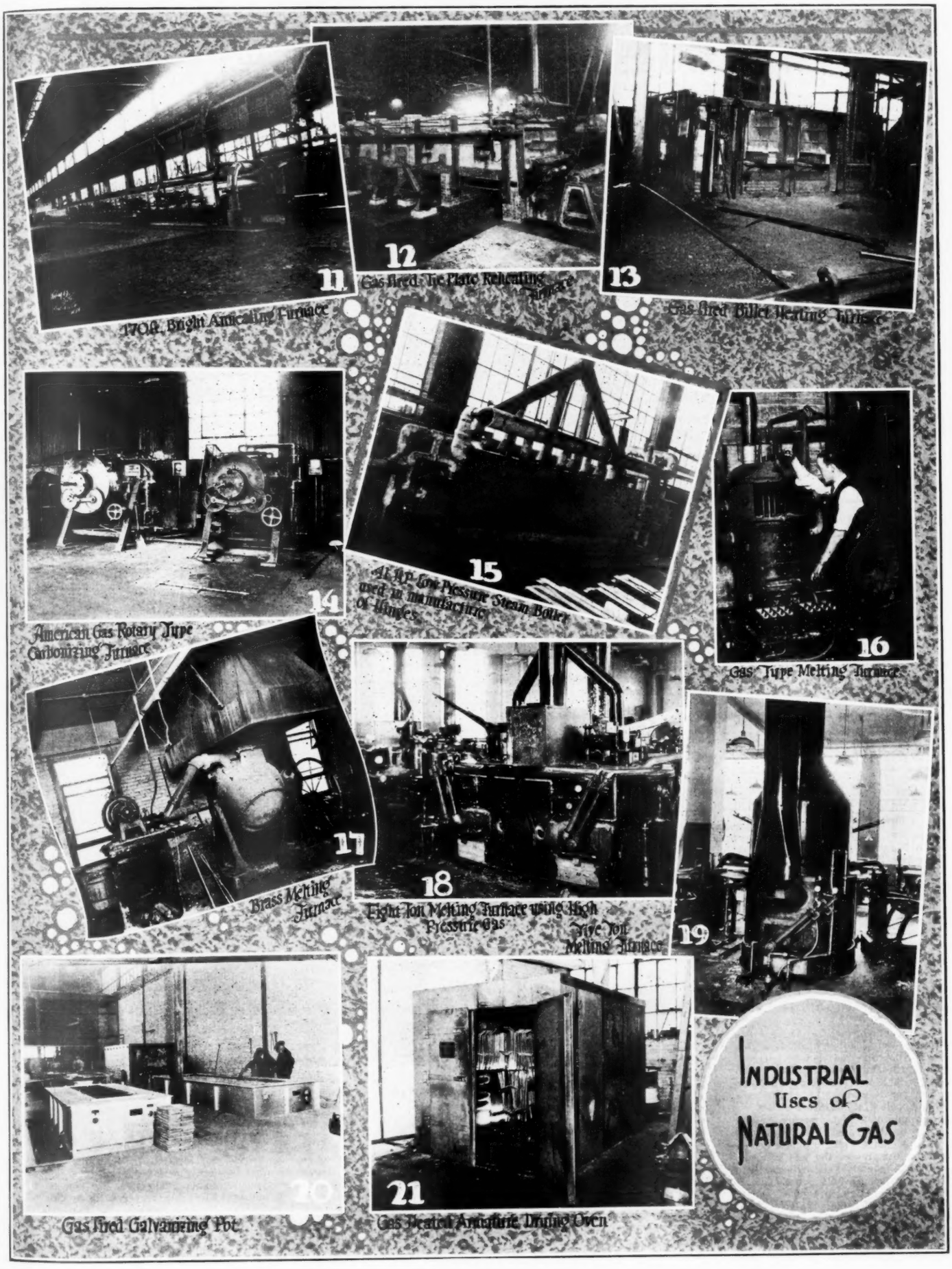
Steam Atomizing Burners, etc.

Ask for Bulletin M

The COEN Company

Oil and Gas Burner Engineers

San Francisco, 112 Market St. — Los Angeles, 428 Story Bldg. — Tulsa, Okla., Mid-Continent Gas Appliance Co. — Houston, Tex., A. K. Miller Engineering Co. — New Orleans, La., A. K. Miller Engineering Co. — New York City, Coen Co., 50 Church St.


11
1704. Bright Annealing Furnace
12
Gas fired Tin Plate Reheating Furnace
13
Gas fired Billet Heating Furnace
14
American Gas Rotary Type Carbonizing Furnace
15
Gas fired Low Pressure Steam Boiler used in manufacture of Hinges
16
Gas Type Melting Furnace
17
Brass Melting Furnace
18
Eight Ton Melting Furnace using High Pressure Gas
19
Five Ton Melting Furnace
20
Gas fired Galvanizing Pot
21
Gas Heated Armature Drying Oven
INDUSTRIAL Uses of NATURAL GAS

making it difficult to have correct proportions of oil and air.

The great adaptability of gas in the particular furnaces used for the various classes of melting has permitted this fuel to meet every requirement satisfactorily. Gas is very often used as the fuel for pit furnaces formerly fired with solid fuel and for all types of open flame or noncrucible furnaces. Advances have been made in melting brass, aluminum and other alloys in a specially designed gas-fired crucible furnace, and in the spherical type of noncrucible furnace. These furnaces handle all classes of melting of nonferrous metals, the selection of type used depending upon the nature of the work and character of the metals melted.

The table following gives a summary of the comparative cost of melting brass with different fuels, based on natural gas at 50 cents per 1,000 cubic feet, manufactured gas at 80 cents per 1,000 cubic feet, oil at 6½ cents per gallon, coke at $6 per ton and coal at $5 per ton:

	80c Mfgd. Gas	50c Nat. Gas	6½c Fuel Oil	$5 Coal	$6 Coke
Fuel	$0.36	$0.18	$0.195	$0.125	$0.15
Crucible	.12	.12	.13	.16	.20
Shrink'g.	.90	.90	1.20	1.05	.96
Labor	.60	.60	.90	1.20	1.20
	$1.98	$1.80	$2.42	$2.53	$2.51

Melting Soft Metal

Illustrations of soft metal melting are shown in Figure 16, a type melting furnace for remelting mono and linotype slugs and casting into pigs. It is thermostatically controlled to prevent the temperature rising high enough to burn the metal. Two thousand five hundred pounds of slugs is the daily charge for which 600 cubic feet of gas are needed, or 245 cubic feet per 1,000 pounds. From a cold start 850 pounds were cast out in 1 hour and 10 minutes on 160 cubic feet of gas with 1.9 per cent metal loss.

A down draft brass melting furnace fitted with a special 5-inch manifold is shown in Figure 17. A bronze containing 65 per cent copper, 25 per cent tin, and 10 per cent lead, is melted in this furnace. Nine hundred and seventy-five pounds of this mixture is melted in 25 minutes with a gas consumption of 328 cubic feet per 100 pounds, or a fuel cost per pound melted of .0016 cent.

An example of a high-pressure gas installation is illustrated by Figures 18 and 19. A single stage, motor-driven compressor compresses the gas from 10 ounces to 25 pounds and delivers it to the stereotype room at 24 pounds, i.e., a 1-pound drop. High pressure impact type burners with single valve control direct the flame against a bed of refractory material underneath the pot and thus an even radiant heat is directed against the pot bottom. Each of four pots in this plant is thermostatically controlled and is also equipped with a pytometer connected in relay to a series of lights to indicate the condition of the metal in the pot.

The working rate of each 8-ton pot is four and one-half 80-pound plates per minute or 270 per hour. Twenty-one thousand six hundred pounds of molten metal are cast in an hour and replaced by pig and old plates. Gas consumption for this production is 1,450 cubic feet per hour, or practically 15 pounds per cubic foot of gas. The constant supply of gas delivered at an unvarying pressure assures a supply sufficient to take care of the highest productive peak.

Galvanizing Industry

Another branch of industry using large volumes of fuel for heating metals is the galvanizing of pipe fittings, sheet metal and hardware specialties. Galvanizing is known as the coating of metal products with zinc to prevent oxidation or rust. The most common methods are the electro or cold galvanizing, sheradizing or dry galvanizing, and the hot dip or wet process.

Manufacturers using gas for galvanizing attest to savings and advantages. In one plant a furnace converted to gas from oil producing annually 30,000 tons of galvanized pipe at a cost of $19.26 per ton as compared to $20.36 with oil, or a saving of $1.10 per ton. In addition there are intangible savings and advantages in using gas, such as—

1. Clean shop and no fumes. Cleaner operating conditions for employes, resulting in reduced labor turnover.

2. Increase production. No running time lost making it possible to operate 24 hours a day.

3. Service at all times, a particular advantage in the case of gas not applicable to any other fuel.

Figure 20 shows a gas-fired galvanized kettle.

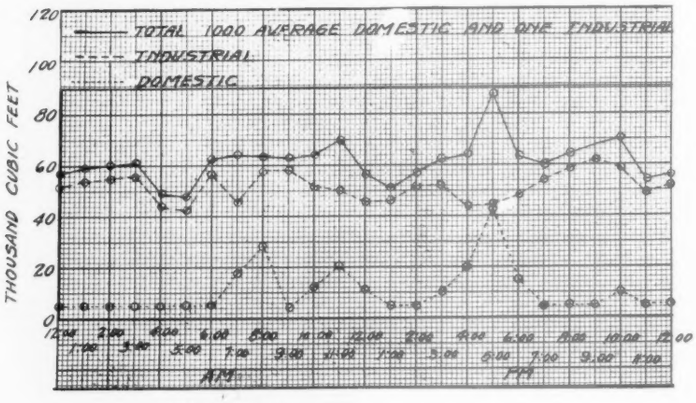
Gas is stepping into industries every day, offering both a better standard of manufacture and more efficient production. In addition to the industries mentioned in this article there are thousands of purposes for which gas can be sold in smaller shops and plants. Figure 21 illustrates a typical gas-fired oven operation in Pittsburgh used for drying armatures and parts at a temperature of 140 degrees Fahrenheit.

Efficient and Economical

The history of many cases where it is used is typical of industrial gas installations in the betterment of working conditions, the elimination of inefficient and expensive methods and the financial advantage which results. Gas is a fuel that burns without waste and in processes of manufacture will introduce simplicity of method and economy of operation.

Manufacturers using fuel appreciate the value of gas and regard it as most desirable, as evidenced by the increased industrial consumption in the manufactured gas industry at much higher prices than anything experienced in the natural gas line. Gas is being used because it means a cheaper finished product. With gas the heat of combustion may be applied to the work at a point where it is most effective and temperatures are subject to very close regulation, which means less waste and spoilage. In many cases the cost of the fuel is far outweighed by the advantages gained in using it, and in many cases of application the manufacturer can only obtain the desired results with a gaseous fuel. The use of gas makes better working conditions because of cleanliness, flexibility, ease of operation, absence of smoke, and cooler shops. Gas lends itself satisfactorily to automatic equipment, which is the trend in industry today.

LOAD CURVES, 24 HOURS, AUGUST, 1926—1,000 TYPICAL DOMESTIC CONSUMERS, ONE TYPICAL AVERAGE INDUSTRIAL CONSUMER



Daily Load Factors:

Industrial	Ave. Hour	52,278	83½
	Max. Hour	62,570	
Domestic	Ave. Hour	10,750	24½
	Max. Hour	44,000	
Total	Ave. Hour	63,028	71
	Max. Hour	88,800	

Graphs Show Conditions

We have 10 consumers who are using a total of 9,000,000 cubic feet of gas a day, which is uniform practically throughout the year. These 10 consumers use as much gas as 30,000 to 35,000 of our domestic consumers. They give us 10 accounts to look after, no peak loads, and the investment is already made, and if the gas is not sold to industrial consumers the balance of the consumers, who are domestic users, must carry the additional investment costs, and the carrying of investment costs is the largest item entering into natural gas rates. One of the accompanying diagrams show the yearly industrial load of a company, its domestic load and the total load. You will notice that the industrial load is practically uniform throughout the year, whereas the domestic load is about four times as much in the winter as it is in the summer, and the conditions are actually much worse than this because in the design of the plant to take care of domestic loads you must take care of not the average month but the greatest winter day, which, instead of four or six times the amount demanded in summer, is frequently as much as 10 times as much as the amount demanded by the domestic consumers during the summer months.

Another graph compares the typical load curve of an industrial consumer with 1,000 average domestic consumers during the month of February, and you will note here the effect of the industrial business is to level the daily load and improve the load factor. The third graph shows the same thing except for a summer day. The following figures show the effect of the industrial business in averaging the yearly load factor of a company for the year 1926:

Maximum Day—

Industrial	22,540 M cu. ft.
Domestic	133,072 M cu. ft.
Total	155,612 M cu. ft.

Total Sales for Year

Industrial	6,234,476,300 cu. ft.
Domestic	17,775,292,800 cu. ft.
Total	24,009,669,100 cu. ft.

Actual Average Daily Sales—

Industrial	17,082 M cu. ft.
Domestic	48,699 M cu. ft.
Total	65,780 M cu. ft.

Load Factors—

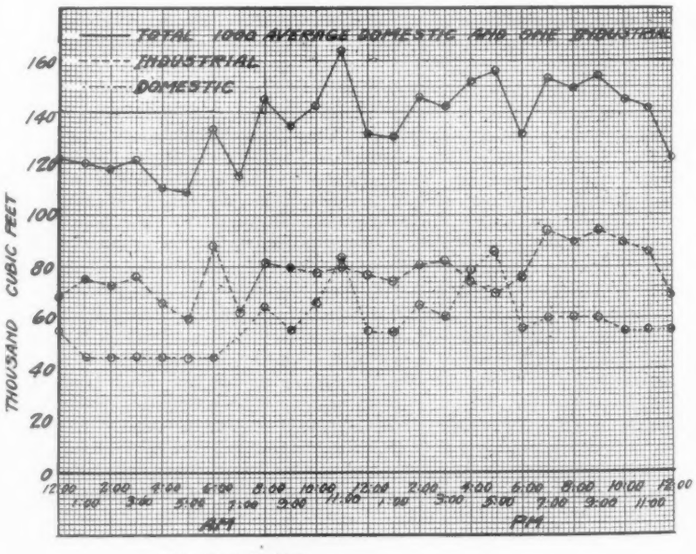
Industrial	Average	17,082 M	75.7
	Maximum	22,540 M	
Domestic	Average	48,699 M	36.6
	Maximum	133,072 M	
Total	Average	65,780 M	42.3
	Maximum	155,612 M	

Industrial Gas Prices

Much of this industrial gas is paying prices close to that being paid by the domestic consumers and much more of it can be held at higher prices as further developments of industrial appliances take place. This business, however, cannot be obtained without a proper organization, sales and engineering forces, to see that the consumer does get the engineering that is required for the particular type of work to be done. No longer can we do a haphazard gas work job, with the idea of selling industrial consumers gas on the basis that we are selling them fuel, giving them an equivalent in B.t.u.'s in natural gas for the same amount that they can obtain with coal or other fuels. This gas must be sold on service and on the basis of what the manufacturer is going to save by the use of gas in his finished products in the way of less waste of material, work done per man and improved working conditions in his plant, thereby saving in many cases considerable floor space.

This business can, therefore, be retained at greatly increasing prices to the benefit of the industry. A careful analysis shows that this business is not only paying its share of the cost of operating, but it is also doing much towards carrying the expenses of the domestic consumer. The domestic consumer is thus benefiting very greatly by this industrial business, because the industrial business helps to carry the investment and operating expenses. Without this industrial business the charges for operating and investment would be nearly as high but would all have to be carried by the domestic consumer.

LOAD CURVES, 24 HOURS, FEBRUARY, 1926—1,000 TYPICAL DOMESTIC CONSUMERS, ONE TYPICAL AVERAGE INDUSTRIAL CONSUMER

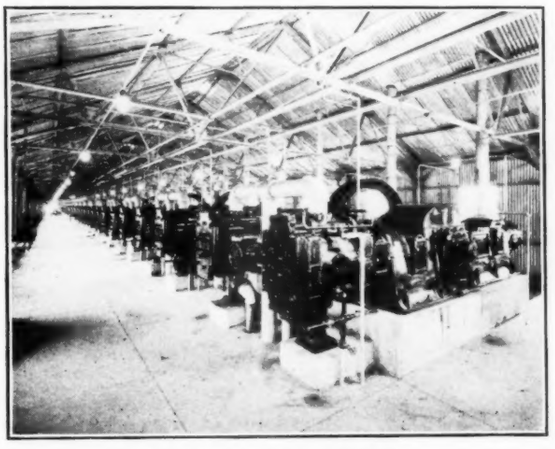


Daily Load Factors:

Industrial	Ave. Hour	78,840	83⅓
	Max. Hour	94,200	
Domestic	Ave. Hour	57,910	67½
	Max. Hour	86,000	
Total	Ave. Hour	136,750	83
	Max. Hour	164,450	

INDCO FABRICATED STEEL BUILDINGS

Exterior view showing big Mid-Continent oil company plant in the Cromwell area. Dimensions 36'x302'x10'.



Interior view of Cromwell plant.

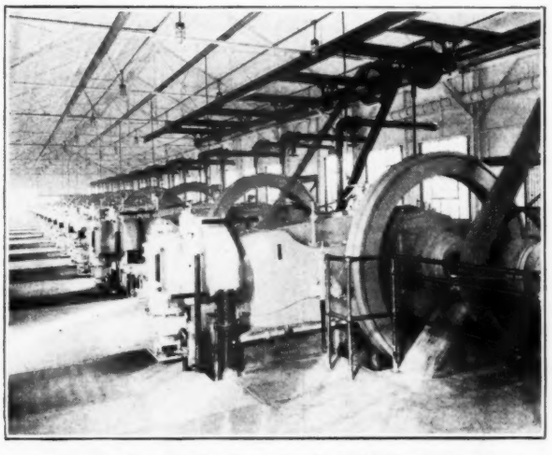
Are Specially Constructed to Meet the Requirements of the Gasoline Industry

To construct gasoline plant buildings economically has long been a problem of the industry. In days past the expense of building heavy concrete foundations and walls was almost prohibitive. To enlarge the capacity required still another large expense.

Today INDCO FABRICATED STEEL BUILDINGS are being built to meet the requirements of a standardized unit system of building construction. Additional units are easily added to meet field expansion. INDCO FABRICATED STEEL BUILDINGS are not of the portable type, but to move them no expense is incurred other than labor—no salvage loss.

In standardizing a unit system we are able to make immediate delivery. Drafting room expense occurs only on first order, as we save templets for the convenience of our customers. The price is standard. Three big Mid-Continent companies are now using the Standardized Unit System.

Exterior view showing large gasoline compression plant located at Madison, Kansas, using standard steel building. Dimensions 36'x144'x14'.



Interior view of Madison plant, showing heavy construction building designed to withstand crane and line shaft loads.

INDUSTRIAL CONSTRUCTION CO.

TULSA INDCO STEEL BUILDINGS OKLAHOMA

A Fair Rate of Return on All Assets

No Fixation Reasonable or Proper Which Does Not Permit Company to Provide Good Service to Consumers.

By Karl F. Griffith
Vice President and Counsel, Lone Star Gas Corp.

What is a fair rate of return on both tangible and intangible assets of a public utility?

The answer to the foregoing interrogation may well be given in the words of a popular song of the present day—"It All Depends." And it does depend upon a great variety of factors, all of which must be given their relative weight in public utility rate regulation or litigation involving rates.

The natural gas business, a very large sister of the oil industry, with some very minor exceptions is and has been subjected to regulation with respect to service and rates by either state or municipal authorities for a number of years. It is interesting to note that the concerns engaged in the natural gas business and classified as public utilities, are the only public utilities which do not and cannot manufacture the commodity which is the basis of their service, that is the natural gas itself. To this extent then, there is a factor present in the determination of a fair rate of return for a natural gas utility, which is not present in the consideration of a fair rate of return for other public utilities.

"Place Utility"

The largest factor in the value of the natural gas itself, is what economists term "place utility" or in other words its accessibility to and availablity for a market or markets. A considerable portion of the property of a concern engaged in the production, transportation and distribution of natural gas has, again according to the economist, only "time utility" since its life is limited to the life of the wells and fields which supply the basic product, natural gas. The term "obsolescence" and proper allowances therefor may be adequate for other public utilities with old facilities succeeded by new and improved facilities, but nothing less than an allowance for complete amortization of much of the property of a natural gas utility will suffice.

Practically all of the litigated questions with respect to the value of public utility property and rate of return thereon, are raised under the Fourteenth Amendment to the Constitution of the United States or similar constitutional provisions of the various states, which provide in substance that property shall not be taken without due process of law. The taking of the use of property, that is the subjecting of the property to the use of the public is construed to be the taking of the property itself, and comes within the purview of the so-called "due process of law" Constitutional provisions.

Modern Regulation

Although regulation of public utilities existed prior thereto, it has only been within the last quarter century that modern public utility regulation has developed. It may truthfully be said that it is only within the past five years that the courts, and particularly the Supreme Court of the United States, have by a number of decisions established certain fixed rules of guidance and eliminated numerous apparent inconsistences in earlier decisions, relating to the regulation and rates of public utilities. The factors necessary for a determination of the fair value of the property of a public utility used and useful in the public service are fixed beyond all doubt by the Supreme Court of the United States in the Southwestern Bell Telephone Case 262 U. S. 276, the Bluefield Water Works case 262 U. S. 679 and the more recent and celebrated Indianapolis Water Co. Case 71 Law Edition 154. A careful reading of these cases is earnestly recommended to all those who are interested in any phase of the regulation of public utilities.

It is assumed that every one has a fairly correct idea of what constitutes tangible assets or tangible property. Opinions may differ as to the value of tangible property but there can be no dispute as to its existence. However, with respect to intangible property, the layman has a rather nebulous idea or opinion. It is our belief that the term "intangible property" as a separate thing, is improperly used in connection with valuations of public utility plants. In explanation of this statement it should be said that practically all, if in fact not all, of the so-called intangible items have gone into, have been merged with, and have become a part of the completed physical plant, even though in evaluation work they are segregated. Of the so-called intangibles there are many, but of ranking importance are: The costs of reproducing the business, including, among other things, preliminary engineering, legal services, supervision and administration, acquisition of capital and interest during construction; the cost of the development of the business (but not the capitalization of losses); and the resultant of the attached and developed business, going value or going concern value.

Going Value

In the Indianapolis Water Case above referred to the opinion of the Supreme Court stated the following with reference to going value:

"A good property has an intangible value or going concern value over and above the value of the component parts of the physical property. . . . Any reasonable man with a knowledge of this property and local conditions would unhesitatingly affirm that it had a value far in excess of the value of the pipes, buildings, grounds and machinery. Consider its earning power with low rates, the business it has attached, its fine public relations, its credit, the nature of the city and the certainty of large future growth, the way the property is planned and being extended with the future needs of the city in view, its operating efficiency and standard of maintenance, its desirability as compared with similar properties. These things make up an element of value that is actual and not speculative. It would be considered by a buyer or seller of its securities."

In addition the Supreme Court said:

"That there is an element of value in an assembled and established plant, doing business and earning money, over one not thus advanced, is self-evident. This element of value is a property right, and should be considered in determining the value of the property upon which the owner has a right to make a fair return when the same is privately owned although dedicated to public use. Des Moines Gas Co. vs. Des Moines 238 U. S. 153; Denver vs. Denver Union Water Co. 246 U. S. 178; Omaha vs. Omaha Water Co. 218 U. S. 180."

Factors Vital to Rates

And now, assuming that a proper evaluation of the entire public utility property has been made, what rate of return shall be allowed as fair and reasonable upon the property valuation? And what is fair and what is reasonable? It would seem that the purpose of one definition is solely to call for another. But, as stated at the outset, what is a fair return depends upon a consideration of numerous factors. These factors are present in all rate regulation and litigation. It may truly be said that these factors are the yardsticks for the measurement of the rate of return.

By rate of return is meant the percentage of the property value made available annually to the owner of the public utility over and above the total cost of rendering the public utility service. It is the profit or income paid to the owner for the use of the public utility facilities. Neither Constitutional nor statutory provisions guarantee to the public utility owner the payment of the return to which the owner may be entitled, the only guaranty is the guaranty of the right to earn a fair return if such is possible under the economic conditions existing.

No arbitrary rate of return, such as 8 per cent, 10 per cent, or something or other, can be fixed or predetermined for any public utility property. The return must be based upon the facts and circumstance found in each individual case. A return which may be amply compensatory on one property may be absolutely confiscatory with respect to another property; for example, it should be obvious even to the unthinking that, a fair rate of return on a water property, having for practical purposes an indefinite life, would not be adequate for a natural gas property.

There has never been a more clear or concise statement on the question of a fair return than that made by the Supreme Court of the United States in the Bluefield Water Works Case hereinbefore cited, wherein the court said:

Supreme Court Views

"The company contends that the rate of return is too low and confiscatory. What annual rate will constitute just compensation depends on many circumstances, and must be determined by the exercise of a fair and enlightened judgment, having regard for all revelant facts, a public utility is entitled to such rates as will permit it to earn a return on the value of the property which it employs for the convenience of the public equal to that generally being made at the same time and in the same general part of the country on investments in other business undertakings which are attended with corresponding risks and uncertainties. . . . . The return should be reasonably sufficient to assure confidence in the financial soundness of the utility, and should be adequate under efficient and economical management to maintain and support its credit and enable it to raise the money necessary for the proper discharge of its public duties."

Spurr, in his work on "Guiding Principles of Public Service Regulation," states that solely from the standpoint of the public welfare, the return must be sufficiently high to secure good service, and that if the rate is less than reasonable, obviously the utility cannot continue to perform its duty to the public; and furthermore that the public interest demands an adequate service rather than a utility struggling against bankruptcy and furnishing only mediocre service because its rates are too low.

It must be remembered that "fair and reasonable rates" mean not only fair and reasonable rates to the public for the service rendered, but also rates which are so fair and reasonable as to provide for the utility its fair and reasonable return. And no fixation of a rate of return will be fair or proper either to the public or the utility unless such rate of return will provide good service, attract necessary new capital and compensate for the risks, the uncertainties, and the hazards which attend the promotion, the development and the operation of the public utility enterprise.

GAS COMPANY SOLVES UNIQUE PROBLEM

P. & A. Photo.

A pair of flat, box-shaped, riveted steel pipes have solved the problem of laying a gas main across Central Parkway, in Cincinnati, Ohio, which parkway is the new automobile boulevard extending along on the surface of the Rapid Transit subway. The Union Gas & Electric Co. has been figuring on how to get the 16-inch gas main supply of gas across the surfacing where there is only a foot depth between the top of the subway concrete roofing and the surface of the parkway paving. The flat pipes solved the riddle. The above photo shows them as they appear lying on top of the subway concrete roof. These pipes are connected with 16-inch gas mains on either end of the subway.

THE ENEMY IS CORROSION

The Protection Is Asbestos

EVEN before the last shovelful has closed the ditch on a pipe line, corrosion attacks begin.

The value of proper pipe line felts in keeping pipes in service long beyond their usual time is now generally recognized by the industry.

Johns-Manville Asbestos Pipe Line Felts are protecting oil and gas lines throughout the world, paying their own cost over and over by adding years to the life of these systems.

Made from rock fibre that cannot rot or decay, an asbestos felt is the logical material to give your lines permanent, reliable protection.

Through Asbestos and its allied products
INSULATION
BRAKE LININGS
ROOFINGS
PACKINGS
CEMENTS
FIRE PREVENTION PRODUCTS

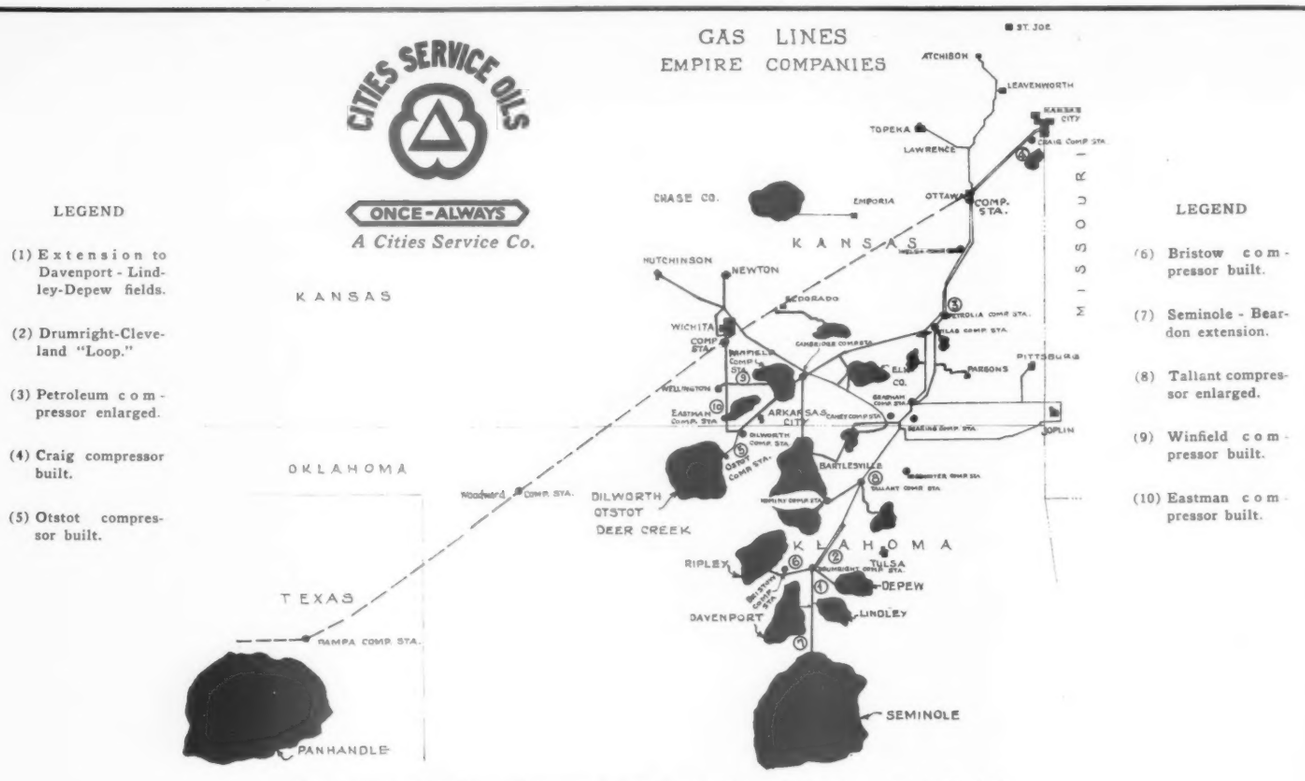
JOHNS-MANVILLE CORP.
292 Madison Ave. at 41st St.,
New York City
Branches in all large cities
For Canada:
Canadian Johns-Manville Co., Ltd., Toronto

JOHNS-MANVILLE
ASBESTOS PIPE LINE FELTS

CITIES SERVICE OILS

ONCE-ALWAYS

A Cities Service Co.



Map of Principal Main Lines and Gas Production of Empire Gas & Fuel Co.

BUILDING A NATURAL GAS SUPPLY FOR THE FUTURE IS A CONTINUOUS PROCESS

The past 14 years of the history of this company have seen a program for the constant development of an ever-increasing supply of natural gas for our domestic and industrial markets in Kansas, Oklahoma and Missouri.

An Investment of $5,000,000 in New Production, New Lines and Facilities for 1926-1927

During the year 1926 more than $2,500,000 was expended in (1) the construction of lines into the Davenport-Lindley gas areas of Oklahoma; (2) the "looping" of the 16-inch main line from Cushing and Drumright to Cleveland; (3) the connection of Chase County (Kansas) gas with Emporia; (4) the building of compressor stations at Bristow and Otstot, Oklahoma, and Craig, Kansas; (5) the enlargement of the Petrolia, Kansas, compressor plant on the main line supplying Kansas City, Topeka and other northern markets, and (6) other important extensions.

During this year of 1927, an equal amount ($2,500,000) will be expended for—

(1) An extension into the natural gas areas of Seminole, Earlsboro and Beardon Fields in Oklahoma;

(2) The "looping" of the north-end of the Cushing 16-inch main line from Cleveland, Oklahoma, to Tallant compressor station;

(3) The enlargement of the Tallant compressor station;

(4) The building of additional compressor stations in the Winfield and Eastman fields in the southern Kansas gas areas;

(5) The building of extensions for industrial purposes at numerous points on the system;

(6) The enlargement of the main line pipeline system from Chanute to Kansas City and other northern cities and towns.

Start $15,000,000 Amarillo Gas Pipeline Project

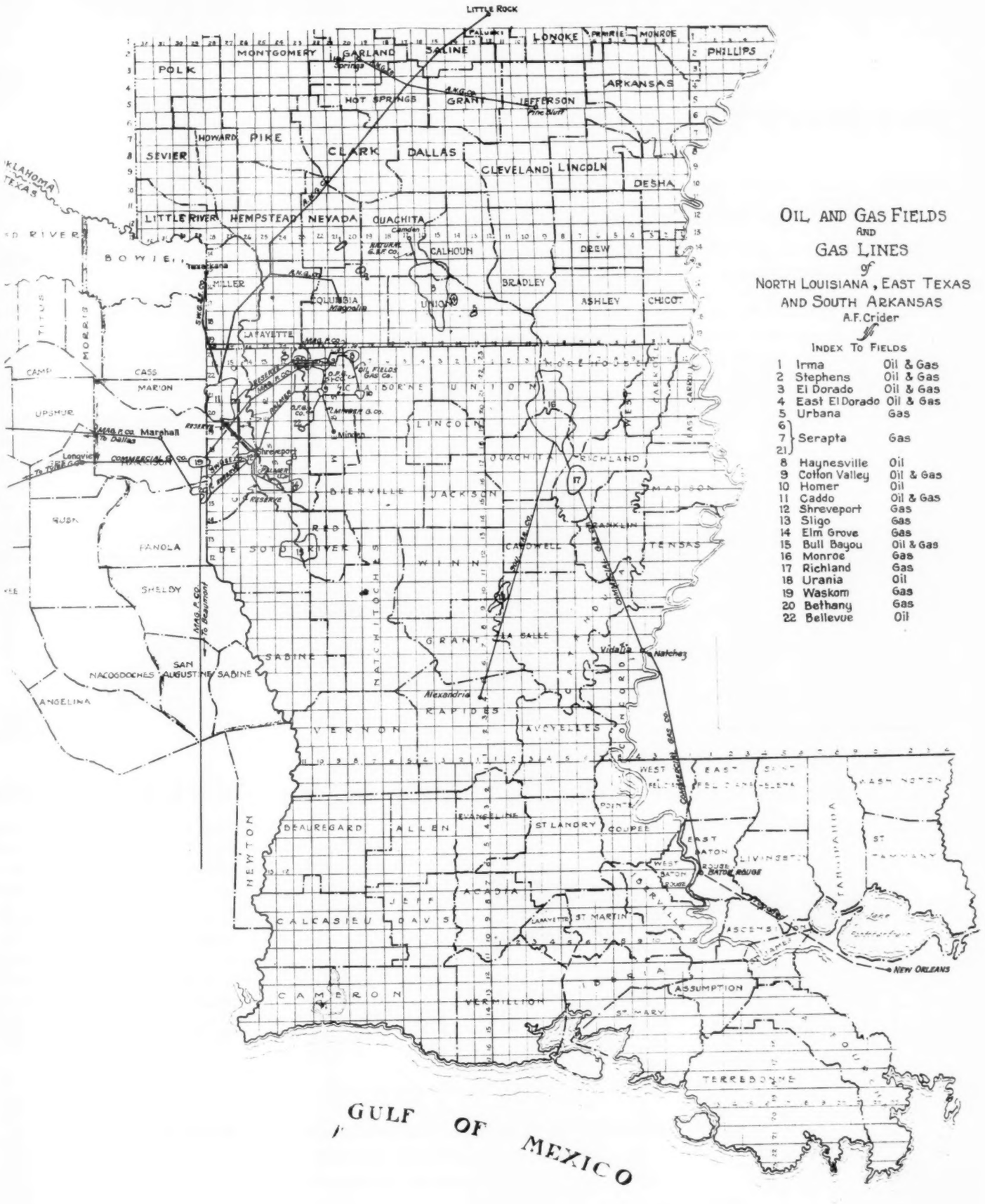
In addition to the above mentioned activities, the Empire and affiliated companies have awarded pipeline and compressor construction contracts for the building of the longest single length of pipeline in the Mid-Continent. This will tap the vast gas resources of the Texas Panhandle and make this gas available for Kansas, Oklahoma and Missouri domestic and industrial users by January 1, 1928.

All of these activities are but a part of the continuous program employed by this company, year after year, in its efforts to keep in advance of the demands of the territory it serves for an adequate supply of natural gas.

*NATURAL GAS DIVISION

EMPIRE GAS & FUEL COMPANY

***The Natural Gas Division is One Unit in the EMPIRE'S Complete Cycle of Production, Pipe Line, Refining and Marketing.**



OIL AND GAS FIELDS AND GAS LINES of NORTH LOUISIANA, EAST TEXAS AND SOUTH ARKANSAS

A. F. Crider

INDEX TO FIELDS

1	Irma	Oil & Gas
2	Stephens	Oil & Gas
3	El Dorado	Oil & Gas
4	East El Dorado	Oil & Gas
5	Urbana	Gas
6, 7, 21	Serapta	Gas
8	Haynesville	Oil
9	Cotton Valley	Oil & Gas
10	Homer	Oil
11	Caddo	Oil & Gas
12	Shreveport	Gas
13	Sligo	Gas
14	Elm Grove	Gas
15	Bull Bayou	Oil & Gas
16	Monroe	Gas
17	Richland	Gas
18	Urania	Oil
19	Waskom	Gas
20	Bethany	Gas
22	Bellevue	Oil

The above map was prepared by A. F. Crider of the Dixie Oil Co., Shreveport, La., as part of a splendid article Mr. Crider has written on the occurrence of gas in Louisiana and Arkansas. This article will be published in The Oil and Gas Journal in the near future.

Lifelong Protection for

For More Than Forty Years

FOR more than forty years, BITUMASTIC ENAMEL has been used to protect steel ships, water mains and oil and natural gas lines *without a single failure* in any instance where this coating has been properly applied. Forty years, in other words, have not been long enough to show how long this durable enamel will live. History repeats itself, however, and engineers may rely on BITUMASTIC ENAMEL to preserve their oil and gas lines for at least this long.

The Canvas Sling Method of Applying

BITUMASTIC
Reg. U. S. Pat. Off.
ENAMEL

Note Thickness

The superiority of BITUMASTIC ENAMEL is due, not only to its greater durability and adhesive qualities, but to the substantial thickness of the coating when properly applied by either the canvas sling or turning rig methods herewith illustrated.

This, for instance, is a cross section of a standard

Protection With

BITUMASTIC ENAMEL provides such a long lived and substantial coating that it is entirely unnecessary to *wrap* a pipe protected in this way. Wrapped coatings, in fact, are usually combined with asphalt and, because of this, are open to serious criticisms. Asphalt, in the first place, does not provide lasting protection. It disintegrates quickly, exposing the fabric which, in turn, absorbs moisture and sags away from the bottom of the pipe. Pockets, holding water, are thus formed and *corrosion is accelerated rather than retarded.*

Write for our complete book—"The Protection of Pipe Lines."

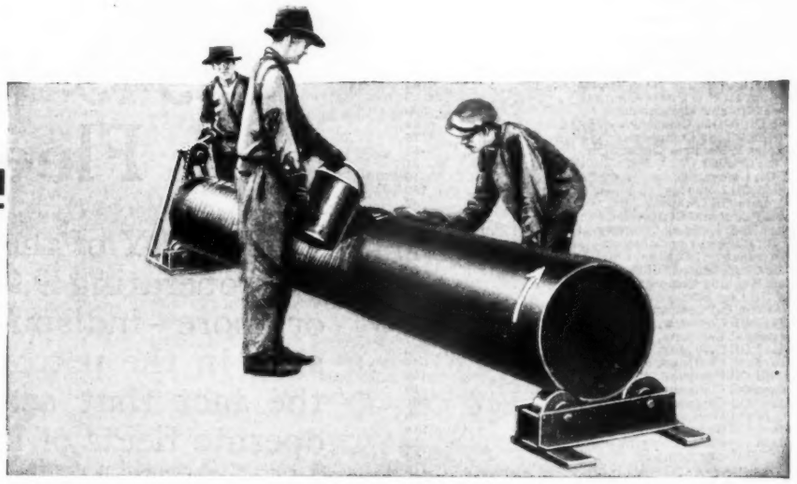
WAILES DOVE-HERMISTON CORPORATION
17 Battery Place, New York
Tulsa, 1 North Frankfort St.

Philadelphia **Cleveland** **Chicago** **San Francisco**

Your Oil and Gas Lines

This Test Will Prove It

WITH the various new and untried pipe coatings now on the market, it may prove difficult to judge of their respective merits. But it is easy to prove that BITUMASTIC ENAMEL will long outlive such coatings. Just take two sections of steel pipe and coat one of them with BITUMASTIC ENAMEL. Coat the second section with any material you may wish to compare. Then immerse them both half way in a saturated salt solution or bury them completely in a cinder fill. Allow them to remain thus buried or immersed for several months and note results. There is *no* substitute for experience.



The Turning Rig Method of Applying

of This Coating

6″ pipe coated with BITUMASTIC ENAMEL. Note that the enamel has been applied to the same substantial .08″ thickness *all around the pipe*. This thickness and uniformity is particularly important at the *bottom* of the pipe where moisture collects in the trench and where trouble is most likely to start.

out Wrapping

When a wrapped line has to be lifted, moreover, the wrapping emerges as a sodden muddy mass which is most difficult to remove, either for examination or recoating.

These difficulties are entirely avoided by the use of BITUMASTIC ENAMEL. When this long live coating is employed, there is neither need for wrapping in the first place nor for lifting and recoating during later years. It is a coating which assures a lifetime of uninterrupted service.

BITUMASTIC

Reg. U. S. Pat. Off.

ENAMEL

Write for our complete book—"The Protection of Pipe Lines."

WAILES DOVE-HERMISTON CORPORATION
17 Battery Place, New York
Tulsa, 1 North Frankfort St

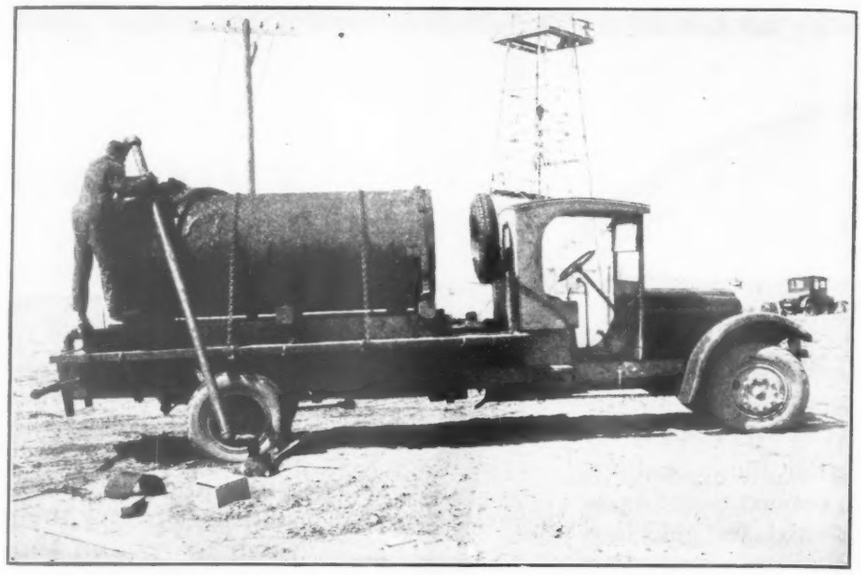
Philadelphia Cleveland Chicago San Francisco

Oil Companies Operating 10 or More White Trucks

American Oil Company	45
American Petroleum Company	37
Anglo-Mexican Petroleum Co., Ltd.	10
Asiatic Petroleum Company	72
Associated Oil Company	11
Atlantic Refining Company	552
*Barnsdall Corporation	38
Barnsdall Oil Company	20
Brooks Oil Company	12
Buckeye Pipe Line Company	25
California Petroleum Corporation	35
Canfield Oil Company	25
Carter Oil Company	10
Cincinnati Oil Works Company	13
*Cities Service Company	67
Cities Service Oil Company	11
Comar Oil Company	25
Commercial Oil Company	11
Continental Oil Company	152
Galena Signal Oil Company	16
General Petroleum Corporation	107
Gerkins Oil Company	13
Gilmore Oil Company	17
Great Southern Refining Company	11
Gulf Pipe Line Company	10
Gulf Production Company	42
Gulf Refining Company	2030
Gypsy Oil Company	42
Huasteca Petroleum Company	38
Humble Oil & Refining Company	58
*Imperial Oil, Ltd.	109
International Petroleum Company	12
International Petroleum Company, Ltd	50
Julian Petroleum Corporation	21
Magnolia Petroleum Company	152
Manhattan Oil Company	10
*Marland Oil Company	10
Marland Refining Company	78
Mexican Gulf Oil Company	26
*Mexican Petroleum Co., Ltd., of Del.	29
Mid-Continent Petroleum Company	15
National Oil Company	30
National Refining Company	73
Ohio Oil Company	40
Oklahoma Pipe Line Company	18
Ozark Pipe Line Company	52
Pan American Petroleum Corporation	84
*Pan American Petroleum & Trans. Co.	44
Petroleum Heat & Power Company	17
Pierce Petroleum Corporation	199
*Prairie Oil & Gas Company	40
Prairie Pipe Line Company	73
Producers & Refiners Corporation	11
*Pure Oil Company	31
Reed Oil Corporation	10
Richfield Oil Company	100
Rio Grande Oil Company	37
*Roxana Petroleum Corporation	446
Shaffer Oil & Refining Company	55
Shell Oil Company of California	202
Shell Company of Canada, Ltd.	13
*Sinclair Consolidated Oil Corp.	22
Sinclair Refining Company	14
Skelly Oil Company	14
South Penn Oil Company	15
Standard Oil Company, of Brazil	25
Standard Oil Company, of California	285
*Standard Oil Company, of Indiana	259
Standard Oil Company, of Kentucky	525
Standard Oil Company, of Louisiana	139
Standard Oil Company, of Nebraska	19
*Standard Oil Company, of New Jersey	261
*Standard Oil Company, of New York	1105
Standard Oil Company, of Ohio	144
Standard Pipe Line Company	18
Stoll Oil Refining Company	30
Sun Oil Company	118
*The Texas Corporation	180
*Tide Water Oil Company	12
Tide Water Oil Sales Corporation	65
Transcontinental Oil Company	17
Union Oil Company of California	823
Vacuum Oil Company	69
Vahey Oil Company	12
West India Oil Company	45
White Eagle Oil & Refining Company	12
Wilshire Oil Company	16
Winona Oil Company	14
Woco Pep Company	11
*Wofford Oil Company	38
Total	9,949

*Exclusive of subsidiary or affiliated companies individually listed.

Let us send you the complete White Roll Call booklet listing a total of 1104 of the country's foremost owners operating 39,857 Whites in fleets of ten or more. Write The White Company, Cleveland, or request it of the branch office or dealer near you.



The White 2½-Ton Truck is an ideal unit for work in the oil fields

90 Oil Companies Use 9949 White Trucks in Fleets of 10 or More

NINETY of the country's leading oil companies operating 9,949 White Trucks in fleets of 10 or more—indisputable evidence of White leadership in the petroleum industry, made stronger by the fact that scores of additional oil companies operate fleets of less than 10 Whites.

These oil companies are successful. They know truck value—they know that Whites can be depended upon to give economical, uninterrupted transportation.

The safest, soundest guide to your own selection of a motor truck is facts. The accompanying list of 90 representative oil concerns operating Whites in fleets of 10 or more is facts—an astounding collection of them.

THE WHITE COMPANY
CLEVELAND

WHITE TRUCKS

And WHITE BUSSES

Natural Gas Development in California

No Field in the State Developed Exclusively for Gas But Its Value Is Very Great for Fuel and Gasoline

By L. C. Decius
Assistant Chief Geologist, Associated Oil Co.

It is the intention of the writer to confine the discussion on the occurrence of natural gas in California to those accumulations of economic importance. At the present time none of the so-called "marsh gas" accumulations is of sufficient importance to be more than mentioned in the following text on Natural Gas of petroliferous source and origin. There is no field in this state developed solely for the production of gas and it is, therefore, hardly necessary to say that natural gas is produced as a by-product of petroleum. It is of course true that the value of such natural gas has been very great both as fuel for domestic and industrial use and as a source of gasoline pressed or absorbed therefrom.

Geographic Features

California, more than any state within the Union, because of geographic and physiographic features, is an isolated economic province in so far as the possible pipe line transportation of its gas is concerned. The great distances northward to centers of population of northern California, Oregon and Washington together with the rough mountainous character of intervening country precludes the economic construction of pipe lines in that direction. The great elevation of the Sierra Nevada Mountains as well as the sparse population of neighboring states on the eastern border precludes the possibility of marketing gas by pipe line to the eastward. Mexico and Arizona to the south and southeast will never use our natural gas due to sparse population and lack of manufacturing industries. The Pacific Ocean bounds the entire western line of the state. It is therefore, readily understood that natural gas produced in California must be marketed within the state as far as can be done economically. At this time communities adjacent to the gas producing fields are consuming all the natural gas production with which they can reasonably be supplied and more gas pipe line facilities are now in the process of construction, particularly from fields within economic distance of the large and growing population of southern California.

Physiographic Features

A general discussion only of the physiographic features of California is sufficient to outline in a broader sense the control of physiography on the occurrence of the oil and gas fields.

The state may roughly be divided into five main physiographic provinces, and in the order of their greatest prominence are named as the Sierra Nevada Mountains bordering the east of the state, the Coast Ranges extending the entire length of the state along the Pacific Coast; the Great Valley comprising the Sacramento and San Joaquin Valleys, constituting a belt of almost level land in the central portion of the state between Tehama County on the north and Kern County on the south; the great expanse of desert region occupying about the southeastern one-fifth of the state; the fifth the Los Angeles Basin which has in recent years startled the entire oil and gas industry with the finding of numerous fields of first magnitude.

The Sierra Nevada Mountain system starting in the northeast corner of the state is comprised of a great granitic block extending along the eastern boundary of the state and terminating in Kern County where it swings to the westward and merges with the Coast Ranges. The Coast Range system extends the entire length of the state along the Pacific Ocean from Oregon to Mexico. The so-called Great Valley of California extending from Tehama County in the north to Kern County in the south, occupying the geographic center of the state, is some 500 miles in length with an average width of 50 to 70 miles and an approximate areal content of 30,000 square miles. The Sacramento River drains the north half of the valley and the San Joaquin the south half. These two great river systems have their confluence in the central western part of the Great Valley and empty through the Coast Ranges into the great navigable inland expanse of water comprising San Francisco, San Pablo and Suisun Bays. The fourth general physiographic province of the state comprises the Mojave, and Colorado deserts. This southeast portion of the state climatically and physiographically belongs to the arid region type of southern Nevada and Arizona. The fifth physiographic province, the Los Angeles Basin which should be more properly referred to as the Los Angeles Coastal Plain might be described as a unit. Actually, however, the Los Angeles Coastal Plain is only a subfeature of the Coast Range Mountain system. It is the present greatest unit when considering the various provinces in respect to gas production.

In a general way gas occurs in California in anticlines and monoclines along the border of the southern end of the Great Valley, where the level plains of the valley merge into the foothill belt of the mountains. In the Coast Range fields it is interesting to note also that the majority of fields occur as for instance in the Los Angeles Coastal Plain, the Ventura Coastal Plain and Santa Maria Coastal Plain in a corresponding physiographic position where these valley plains merge into the foothills of the mountainous country.

It is true that the physiographic features are the result of the diastrophic movements which have developed the structural features and thus the physiographic features must be considered as consequent to the structural features of the state. It should therefore, be understood that the gas bearing structures have been formed where the Tertiary sediments are folded into favorable structures for accumulation, on the rims of the great valleys and coastal plains. There are naturally a few exceptions to this general occurrence of oil and gas as controlled by geologic structure and physiography but for the main problem the above description fairly well includes the problem of oil and gas accumulation in California.

Occurrence of Gas

The stratigraphic distribution of gas as well as oil in California ranges throughout the entire Tertiary system, including the Eocene, Oligocene, Miocene and Pliocene formations which are divided into a perfect geological puzzle of local names for those who are not familiar with the geology of the state.

Before passing on to further descriptions of the above series of rocks it is well to mention here the occurrence of oil and gas in the upper Cretaceous north of Coalinga. This occurrence has been of only small consequence and has not led investigators in the industry to expect much oil or gas from similar Cretaceous rocks which occur from Coalinga northward to the Oregon line. Thus with the present elimination of the Cretaceous rocks and of other formations older than the Cretaceous we may say that the past as well as future California oil and gas industry will probably be confined to those regions occupied by Eocene, Oligocene, Miocene and Pliocene rocks.

Eocene

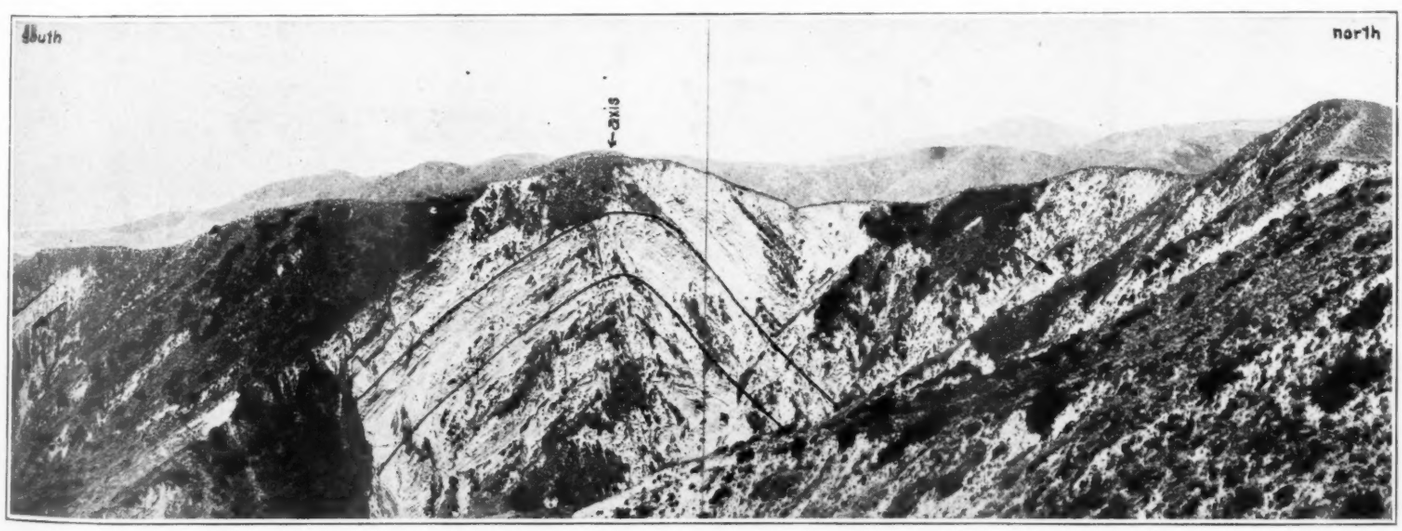
The occurrence of oil in this formation is not widespread nor does it comprise a great proportion of the total production of the state. The Eocene sediments in Santa Barbara and Ventura Counties, locally called Topa Topa formation are undoubtedly the source of a considerable production of oil and gas in the Santa Clara Valley oil fields of Ventura County and might possibly constitute the source of some of the oil of Santa Maria Field although this latter is unlikely. The Tapo Canyon Field (No. 55 on Plate 1) in Ventura County is producing oil from an accumulation within the Eocene rocks themselves. The Bardsdale, Shiells Canyon, South Mountain and Torrey Canyon fields of Ventura County are producing oil and gas from the Oligocene rocks and possibly some wells in these fields have drilled into the upper part of the underlying Eocene. These particular oil and gas accumulations at any rate must have had their source in Eocene shales immediately underlying the Oligocene.

Oligocene

The Oligocene formation has been the subject of a great deal of controversy between geologists working in sedimentary rocks but in as much as this time has no definite place in the present discussion it may be well here to accept as Oligocene in age the Kreyenhagen shales, occuring along the west border of the San Joaquin Valley, as a source of oil and gas in the Coalinga Field. Oil and gas from these shales has accumulated in the Lower Miocene or Vaqueros formation. The Sespe formation of Santa Barbara, Ventura and Los Angeles Counties, described as Oligocene, is the horizon of accumulations of very important quantities of oil and gas. It has not been noted above that the Bardsdale, Shiells Canyon and South Mountain fields are producing gas from Oligocene rocks. The gas in these fields is particularly rich in gasoline content although the quantity of gas produced per barrel of oil is not unusually high.

Miocene

Miocene rocks are generally and correctly interpreted in California as the source of probably more than 90 per cent of the production of the entire state. The Miocene shales carrying different names in different geographic regions, such as



Ventura Anticline, 4 miles west of Ventura Avenue Oil Field.

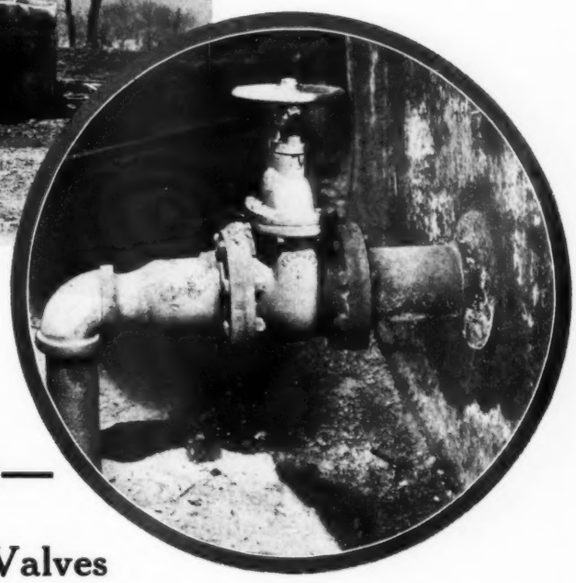
Monterey, Maricopa, Salinas and Puente, are for the main part a great thickness of diatomaceous material which has been the source of gas accumulation in both the Miocene rocks themselves and the overlying Pliocene formations. Important fields in California producing from accumulations of the Miocene are Coalinga, Santa Maria and Lompoc.

Pliocene

Just as the Miocene and Pliocene constitute the source and accumulation respectively of over 90 per cent of oil and gas of California so does the Pliocene constitute the source of probably more than 90 per cent of the accumulation between the Miocene and Pliocene. There are no recognized important sources of oil and gas within the Pliocene rocks themselves so we may safely assume that the oil and gas accumulated in the Pliocene rocks has had its origin in the shales of the Monterey formation. Important fields producing oil and gas from Pliocene rocks may be enumerated in the order of their occurrence on Plate No. 1 as Buena Vista, Elk Hills, McKittrick, Midway, Sunset, Dominguez, Inglewood, Long Beach, Montebello, Rosecrans, Seal Beach, Santa Fe Springs, Torrance, East Coyote, West Coyote, Huntington Beach, Richfield and Ventura Avenue.

It is of interest to note in a comparative way the absence of limestones in the above described Tertiary formations of the State of California. Little if any limestone has been deposited as such although there are some secondary calcareous beds included in these formations. The Eocene rocks comprise both sandstones, organic shales and mud shales. The Oligocene Kreyenhagen is composed of organic shales and the Sespe Oligocene is composed of sandstones and muddy shales. The Miocene is composed of great thicknesses of organic shales, in part siliceous and in part occurring as chalklike deposits of diatomite, as well

50th Anniversary 1877-1927



Fire destroyed the tank—

but the Kennedy Valves remained in perfect condition

AFTER the disastrous fire that destroyed the tank shown above, the Kennedy Standard Gate Valves with which the tank was equipped were found to be entirely uninjured and in perfect operating condition.

A more severe test than this could hardly be imagined, and is conclusive evidence that even the ordinary Kennedy standard gate valves can be relied upon in any emergency.

The Kennedy 400-lb., 700-lb., 1000-lb., and 1600-lb. gate valves designed specially for the oil industry are particularly sturdy and rugged, and their thorough reliability has been proven in both ordinary and exceptional operating conditions. The special features of these valves are fully described in the Kennedy Catalog which will be sent on request.

THE KENNEDY VALVE MFG. CO. ELMIRA, N.Y.

Branch Offices and Warehouses:
NEW YORK, 128-132 White St.
BOSTON, 47 India St.
CHICAGO, 1335-1337 S. Clinton Street.
SAN FRANCISCO, 448-450 Tenth Street.

Sales Offices:
Philadelphia
Cleveland
Atlanta
Salt Lake City
El Paso
Seattle
Los Angeles

KENNEDY

VALVES-PIPE FITTINGS-FIRE HYDRANTS

Some Kennedy Products for the oil industry

Cast Steel Fig. 923

Fig. 192 1600-lb. Test

Fig. 301

Fig. 611

Fig. 201

ARMORED HYDRALT

UNDERGROUND pipe protection is in its essence a waterproofing problem, since, if moisture is kept away from metal, corrosion cannot occur.

An investigation of many of the country's largest engineering operations carried out since 1912 has shown that the great majority of them have been waterproofed with an asphalt refined from a heavy asphaltic base oil.

Armored Hydralt is a method by which such an asphalt of low melting point may be economically applied to pipe and then encased in Portland cement, the asphalt being placed without heat, the cement being applied dry without mixing. The result as illustrated in the above cut.

Good adhesion is the starting point in any pipe coating material—and adhesion that is a property of the material itself and is not obtained through the medium of a short lived bituminous paint primer.

Adhesion in bituminous materials depends on the melting point—the lower the melting point the more perfect the adhesion.

Hydralt is a low melting point asphalt but because of our patent method of applying it, it can neither run off the pipe nor be broken or rubbed off.

Armored Hydralt is the only process by which a low melting point asphalt may be used and its undesirable physical properties kept under proper control while at the same time its advantages are left unimpaired.

Tests have proven that a wrapped coating is always more efficient than the same coating unwrapped. The cement shell serves as a casing which will greatly exceed in durability and efficiency any known form of wrapping, and at the same time effectively protects the soft asphalt from abrasion or displacement by the fill or surrounding soil.

Armored Hydralt is nearer the positive, final solution to the problem of pipe corrosion than any other method of coating pipe that has been evolved up to the present time, and is therefore the longest step forward that has yet been taken in the direction of positive pipe protection.

Representatives in all American Oil Fields.

J. B. W. GARDINER, Inc.

50 Church Street, New York

NOTE: The use of dry cement with bituminous emulsions to form a hard coating over them is thoroughly covered by patent application and is not authorized except by agreement with this company alone.

as great thicknesses of sandstone. The Pliocene rocks carry no important organic members but are composed chiefly of shales, sandy shales and sandstones.

The thicknesses of the above formations vary from one geographic province to another and have the maximum average at points of their greatest development as follow: Eocene—9,000 feet, Oligocene—4,000 feet, Miocene—9,000 feet. Pliocene rocks reach their greatest known thickness in the region of Ventura Avenue oil field where the author has measured 21,000 feet of these sediments. The exposed rock section here affords a continuous outcrop so there is no possibility of duplication of these beds due to faulting.

Historical Development

The early history of oil development in California to some degree compares rather closely with that of development in Pennsylvania. The problem of discovery in California, however, was much less difficult than in Pennsylvania due to the actual outcrop of oil bearing sands which could be seen and which incited the imagination of the earlier pioneers of possible future use. Los Angeles and Ventura County fields were the first to attract any considerable attention as these counties were further developed economically and outcrops of oil bearing sands came under observation of a greater number of people. In the early development of the oil industry tunnels were driven into the oil bearing sands and seepage oil was slowly drained from the oil bearing formations.

The great lack of fuel on the Pacific Coast was a source of considerable concern to the early railroad pioneers and in their search for a fuel in the absence of coal it is said that in the very early days of railroad construction Senator Stanford caused the investigation of various oil deposits throughout the length of California. The enormous quantities of California fuel oil since consumed by the Pacific Coast railroads indicates the vision of that early pioneer. Some of the old pits and tunnels dug in the outcropping oil bearing sands may still be seen today as a mounment to the crude methods employed in the early days.

It was not until about 1870 that men with an understanding of the oil production industry began the exploitation of California fields. The development naturally started in those places where actual evidence of oil could be seen on the surface. Ventura County where the geologic formations are beautifully exposed through sections of several thousand feet and present many and various outcrops of oil and gas bearing sands was the first district to attract any concerted effort in the production of oil. We have no record of the use of gas produced with the oil at that time but it is certain that this gas found no further use than the immediate domestic consumption in the fields where it was being produced.

In about 1890 with a fast growing population of the Pacific Coast, well directed efforts on the part of a few pioneers in the industry began to obtain gratifying results. During 1890 a considerable amount of oil was developed in the Ventura region and in addition the Coalinga and McKittrick Felds in the San Joaquin Valley were put on production. In 1891 the Sunset Field of San Joaquin Valley was brought in thus opening one of the great oil and gas producing fields of the State, later to become a very important gas producing area where large amounts of gasoline are extracted from the gas and the resultant dry gas piped to domestic markets. From this time on the major oil and gas fields of California were intermittently brought in until at the present time the 57 more or less individual producing fields as shown on Plate 1 have been developed.

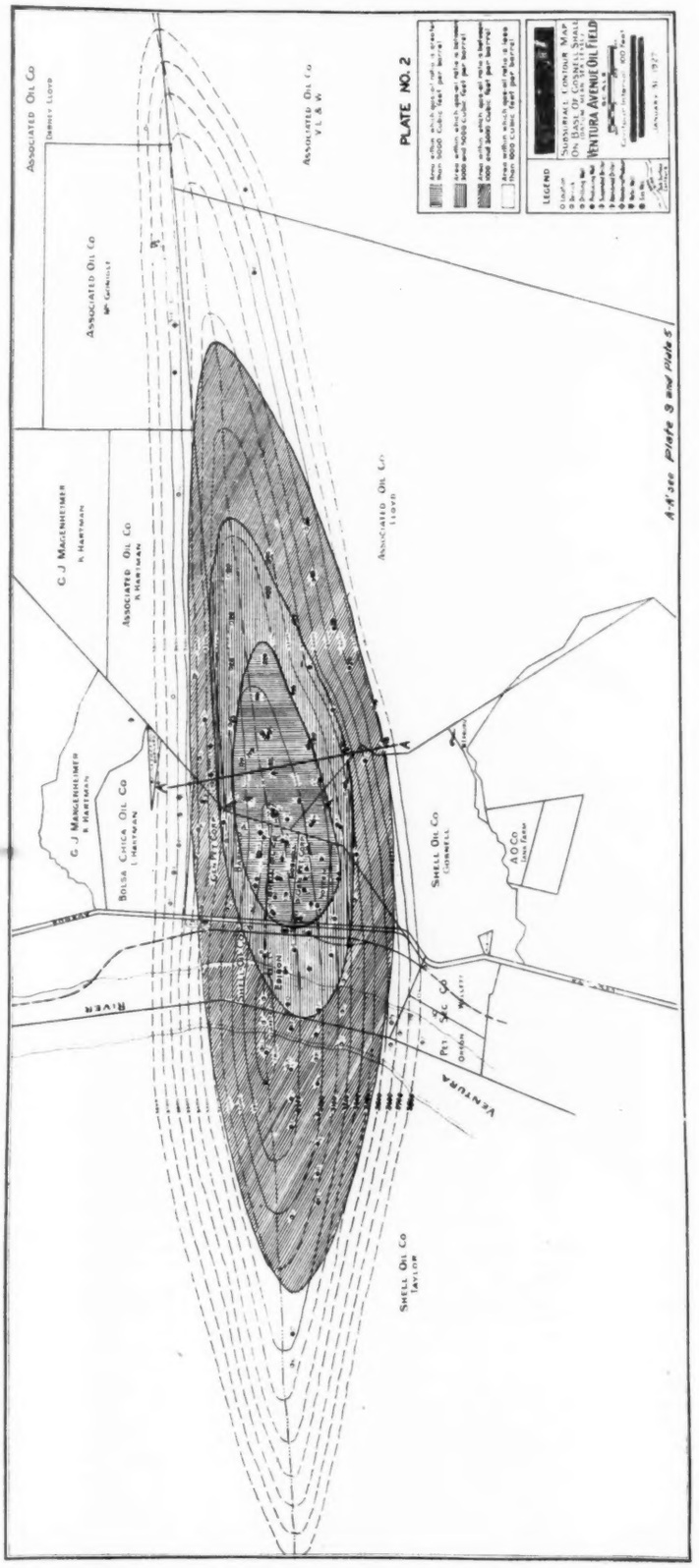
All the California fields producing gas to a greater or lesser degree show that as formerly stated the oil producing fields of the State are all potential gas fields.

Stratigraphy

A brief discussion of the stratigraphy of the Tertiary of California is included under the occurrence of gas in the foregoing part of this paper. Something further should be said here in regard to the detail of the tertiary formations which have given origin to and accumulated oil and gas within their various horizons.

Eocene

This formation carries numerous local names throughout the State of California where it occurs. The most approved terminology would divide the Eocene into lower, middle and upper. Lower Eocene, Martinez formation, reaches its greatest development in a thickness of 3,500 feet in Ventura County. Like most of the Tertiary formations of California the Martinez may, in a given locality, be a shale, a sandstone, or a sandy shale body. The Martinez contains some shale members which may be the source of some oil and gas included in upper members of the Eocene or even higher in the geological section. The middle Eocene is commonly recognized as the Meganos formation, attaining a thickness of as high as 3,000 feet in its greatest development and like the Martinez may carry sand and shale in the same locality or may prevail either as a sandstone or a shale formation. The upper Eocene is commonly known as the Tejon formation and attains a thickness in its greatest development in excess of 2,000 feet. This formation likewise may be either sand or shale according to the geographic location within the state.



Oligocene

This rock series is represented by organic shale members such as the Kreyenhagen shale on the west border of the San Joaquin Valley, by the Sespe sandstones and shales and by the Butano formation. The Kreyenhagen shales are organic in nature and are believed to be the source of much of the California oil accumulated in the lower Monterey rocks in the Coalinga region. These shales reach a maximum thickness of nearly 2,000 feet. The Butano sandstone has been assigned to the Oligocene series. It also reaches a thickness of approximately 2,000 feet. The Butano formation contains foraminifera tentatively determined as lower Miocene and may be the equivalent of one or more of the formations here called Oligocene. The Sespe formation, so well developed in Ventura County, reaches a maximum thickness of approximately 4,000 feet or more and is for the most part a series of poorly stratified varicolored sandstones and earthly clay shales, with so far as the author knows, no primary organic material. The Sespe due to its porosity forms a very favorable series of rocks within which oil and gas may accumulate from underlying formations.

Miocene

This rock series, the most valuable economically of the Tertiary group of California has consequently been the subject of greatest discussion. The lower Miocene where present is usually composed of a medium to coarse sandstone with a district fossil fauna and the name Vaqueros is quite generally accepted for this horizon, although other names have been proposed and so far accepted for local phases of lower Miocene sedimentation. The Vaqueros formation where other conditions are favorable affords an excellent reservoir horizon for the accumulation of oil and gas. The Temblor group also of lower Miocene age is so similar to the Vaqueros that they are often confused and even technically there is still some doubt as to a possible separation of these two formations.

The Monterey shale, middle Miocene, also described in various localities as Maricopa shale, Salinas shale and Puente formation is one and the same thing. This group of sediments is by far the most important economically of any local series in the State of California as a source of oil and gas. The Monterey group reaches a total maximum thickness of approximately 9,000 feet the greater part of which is an extremely rich organic shale and which has been the source of enormous amounts of accumulated oil and gas occurring usually in the overlying upper Miocene and Pliocene rocks. Even this wide spread shale formation has its sandstone equivalent in some parts of the state. Middle Miocene rocks in many places are found in an highly siliceous phase, in other places as pure chalklike shale abundant in organic remains, and in yet other places as an earthly shale carrying sparse amounts of organic material. It is established beyond any reasonable doubt that the middle Miocene shales are the main source of at least 90 per cent of California oil and gas.

Upper Miocene

The middle Miocene shale is recognized in some places as constituting the uppermost Miocene present but in so far as there has been a distinct upper Miocene sedimentation differing from the middle Miocene and in most localities termed the Santa Margarita it is best to recognize in a general way the Santa Margarita sedimentation as constituting the upper Miocene formation. The Santa Margarita may be either sand or shale. It is found in some localities in angular conformity with the Monterey series and in other places in angular unconformity with the Monterey. The Santa Margarita carries oil and gas accumulations but not in any importance as compared with the Pliocene series overlying it.

Pliocene Formation

The Pliocene is the uppermost or youngest series of rocks in the state which carries oil and gas accumulations.

It is possible though improbable that some of the lower shales of the Pliocene series may carry primary organic material which has been the source of some of the oil and gas accumulated within its members. In a general way the Pliocene is divided into the upper and lower groups. Lower Pliocene in the San Joaquin Valley fields is divided into Etchegoin and Jacalitos formations. Upper Pliocene is divided into the Paso Robles and Tulare formations. In the southern coastal ranges and in the Los Angeles coastal plain the Pliocene is recognized as the Fernando formation and has recently been separated into the Pico formation, lower, and Saugus formation, upper Fernando. Thus lower Pliocene comprises the Etchegoin and Jacalitos formations in the San Joaquin Valley and the Lower Fernando or Pico formation in the Southern Coastal ranges. This lower Pliocene in both cases is the horizon of accumulation of the greatest amount of oil and gas derived from the middle Miocene.

The Pliocene rocks in California are composed entirely of sandstones and shales with the former predominating. Reference to Plate 3 accompanying this report gives some idea of the great thickness of oil and gas producing horizons found in lower Pliocene sandstones. As has been stated formerly the Pliocene series reaches a total maximum thickness in the Ventura Avenue Field of 21,000 feet.

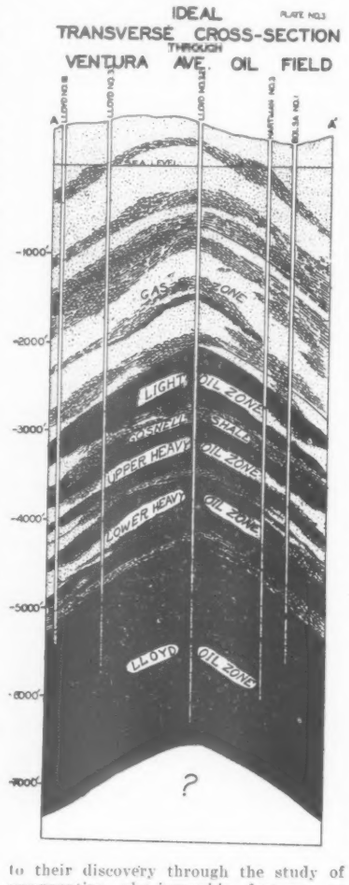
In this particular field it is shown that there are more than 3,000 feet of oil and gas bearing sands, and further the base of the formation has not yet been reached by drilling. Similar conditions of productive thickness of sand is found in the Long Beach Field in the Los Angeles Coastal Plain. The Ventura and Long Beach Fields however stand out incomparable with respect to thickness of oil and gas producing horizons. Thicknesses of oil and gas accumulations within the lower Pliocene rocks in fields other than the two above enumerated range from 20 feet to several hundred feet.

The foregoing brief discussion and description of the petroleum bearing Tertiary rocks in California would lead the casual reader to conclude that in drilling operations the determination of certain horizons at a given depth in a well would be extremely difficult. There is no great difficulty in determining when the drill has passed from Pliocene rocks into Miocene, from Miocene into Oligocene or from Oligocene into Eocene. Microscopic paleontological work in recent years has been of great assistance to geologists in the determination of horizons being drilled, not only in developed fields but in wildcat territory. The great thickening and thinning of Tertiary formations in the state has made it practically impossible, particularly in wildcat regions, to ascertain the horizon at which a well may be drilling without the aid of paleontological data. It is entirely possible to have a given formation thin out or thicken to the extent of a thousand feet in the matter of only a few miles so that the determination of horizons by thicknesses measured on outcropping formations is very hazardous if applied to drilling wells. Recent microscopic work has made it possible to determine not only the various members of a given formation but in some instances to determine definite horizons within individual members themselves. Perhaps the most valuable and notable of these features is determination of the so-cal'ed Scalez zone between the Tulare and Etchegoin formations in the San Joaquin Valley. The oil members in that vicinity occur immediately below the Scalez zone found at the base of the Tulare formation. In the Los Angeles Coastal Plain where the Saugas formation is the time equivalent of the Tulare and the Pico formation more or less the time equivalent of the Etchegoin, microscopic fauna is of great assistance in determining when the drill has passed from the Saugas into the Pico.

Structure

Gas deposits of economic importance occur in California under three general structural conditions. Closed anticlines are naturally of the greatest importance and afford fields of the greatest productivity. Faulted monoclines are of secondary importance and have afforded some of the highly prolific producing areas of the state. Open monoclines have also afforded oil and gas of considerable importance. In these instances the asphaltic residue which has remained within the outcropping rocks at the surface after dissipation of the lighter hydrocarbons to the elements has acted as a barrier, sealing with a greater or lesser degree the remaining oil and gas content of the sand below it.

The problems of areal and structural mapping to locate possible accumulations of oil and gas has in the past been extremely simple due to the abundance of surface data observable by the geologist. Ordinarily the surface data has been of such abundance that the areal mapping of structures has been merely a case of walking over the ground. Very little has been left to the imagination until recent years when such fields as Huntington Beach, Long Beach, Seal Beach, Dominguez and Rosecrans have been discovered. These fields, although affording very few and doubtful rock outcrops, were predicted by some geologists in the State of California several years prior



to their discovery through the study of comparative physiographic features as related to structural conditions. At least 45 of the oil fields shown on Plate 1 accompanying have presented definite surface evidence of structural conditions favorable to the accumulation of oil. In the mapping of these structures it has been unnecessary to employ any other means than the pocket compass. In all the remaining fields there has been more or less evidence of structural conditions which could be detected through topographic and physiographic features and in most cases this evidence was sufficiently strong to warrant the prospecting of the particular territory. Ten years ago, before the discovery of some of the oil and gas bearing structures which were evidenced only by physiographic and topographic features, there was much speculation as to whether or not there would be many more oil and gas fields discovered in California. Now at this time even though we can say that within our present knowledge it appears that most of the fields have been discovered, it would seem unreasonable indeed to assume that we would not find more fields of major importance within the state.

The included photograph, Ventura anticline, will show in a large measure the simplicity of determining structures in California from surface outcrops over the greater portion of the oil bearing regions.

Faults

Ordinarily the accumulation of oil and gas caused by faulting has been manifested at the surface by seepage. A very notable exception to this is seen in the Inglewood Field in the Los Angeles Coastal Plain. Immediately adjacent to the present developed Inglewood field a very favorable looking anticline occurs in the same series of rocks. This anticline was tested by drilling several wells to more than 5,000 feet and it was not until a test well drilled considerable distance southwest of the anticlinal axis and apparently too far down the flank to obtain any accumulation in the anticline itself, made a discovery. Later evidence by drilling has proved beyond any doubt that a fault paralleling the anticline itself has stopped the migration of oil toward the axis of the anticline and has caused a large accumulation well down the flank. Only slight evidence of this fault existed at the surface but as is so often the case this fault can now be determined after development work has so well disclosed its existence.

Other fields in the state which owe their accumulations to faults of considerable magnitude are McKittrick, and Brea Olinda. The surface evidence of faults in these fields is very easily seen and their importance very easily understood. The displacement along the fault lines of both of these fields has been of such magnitude that the oil bearing horizon have been tilted on edge and even overturned.

Open Monoclines

The West Side Coalinga and much of the west side of Midway Sunset Fields in San Joaquin Valley present the interesting problem of high productivity of oil and gas from sands exposed and seeping oil at the surface. In the West Side Coalinga Field the Vaqueros (lower Miocene) sands in which the oil occurs, outcrops at the surface as a tar sand. Wells drilled into this sand where it is found at only a few hundred feet in depth have been producers of oil and gas in very large quantities. It is interesting in such accumulations to note that the gravity of the oil increases with the depth of the sand and greater distance from the outcrop.

Subsurface Structure

Reference to Plate 2 shows how an almost perfect anticlinal structure as mapped by surface outcrop of rocks has developed a likewise perfect subsurface structure. By perfect of course is meant the value of the structure for accumulation and retention of oil and gas. From the apex of the structure represented in Plate 2 there is a strong plunge along the axis both easterly and westerly of from 5 to 10 degrees. The dip of the flanks of the anticline ranges from 25 to 45 degrees. The subsurface contours having an interval of 100 feet are seen to completely close the structure within the present proved area comprehended between Shell Taylor No. 16 on the west and Associated Oil Company's Ventura Land and Water Well No. 1 on the east. In as much as the field is not completely developed it should be noted that many of the contours are dashed throughout part of their closure. There is 1,000 feet of closure within the proved area as developed at this time. The balance of this anticlinal structure in its extent both to the westward and eastward continues to close so that the structure itself regardless of what may prove to be oil bearing in the future would no doubt have a closure of more than 2,000 feet. Throughout the length and breadth of the structure rock exposures are to be found almost at will. The geologist will therefore appreciate my former statements of the simplicity with which some of the California structures are mapped on the surface.

The axis of the subsurface structure in the Ventura Avenue Field on an average lie 500 feet or more south of the axis as mapped at the surface. This is naturally due to the steep dip of rocks on the north flank of the structure having caused the axis to hade southward with depth. See Plate No. 4 accompanying.

About 20 years ago petroleum engineers and geologists of California started systematic work on the correlation of subsurface data. The benefit to the oil and gas industry of California which has been accomplished by this subsurface work has been so great that could it be estimated in dollars and cents the total would be an astounding figure. Subsurface mapping through correlation and various sand, shale, oil and gas and water horizons has directed later development work in the various fields, as has been said for some 20 years. This type of petroleum engineering has recently been augmented by the study of microscopic organism where megascopic faunas are wanting so that today we depend not only upon core and drill samples taken from various sand and shale zones, but on microscopic fossil evidence from drill samples for fixed points of demarkation between certain rock horizons.

The core barrel is an instrument of great value in the study of underground conditions. It is so much easier to understand conditions of saturation, cementation of sand, etc., when we are able to see the various samples in an almost unchanged state before us than it is to attempt to reconstruct mentally the underground picture from samples churned up by standard tools or ripped up by rotary tools. The core barrel is also destined in the near future to serve a further purpose in determining subsurface structure when one of the various technologists working on new devices may eventually lock the compass on the core to be extracted and determine the direction of its dip some thousands of feet underground by bringing it to the surface properly oriented as to its strike.

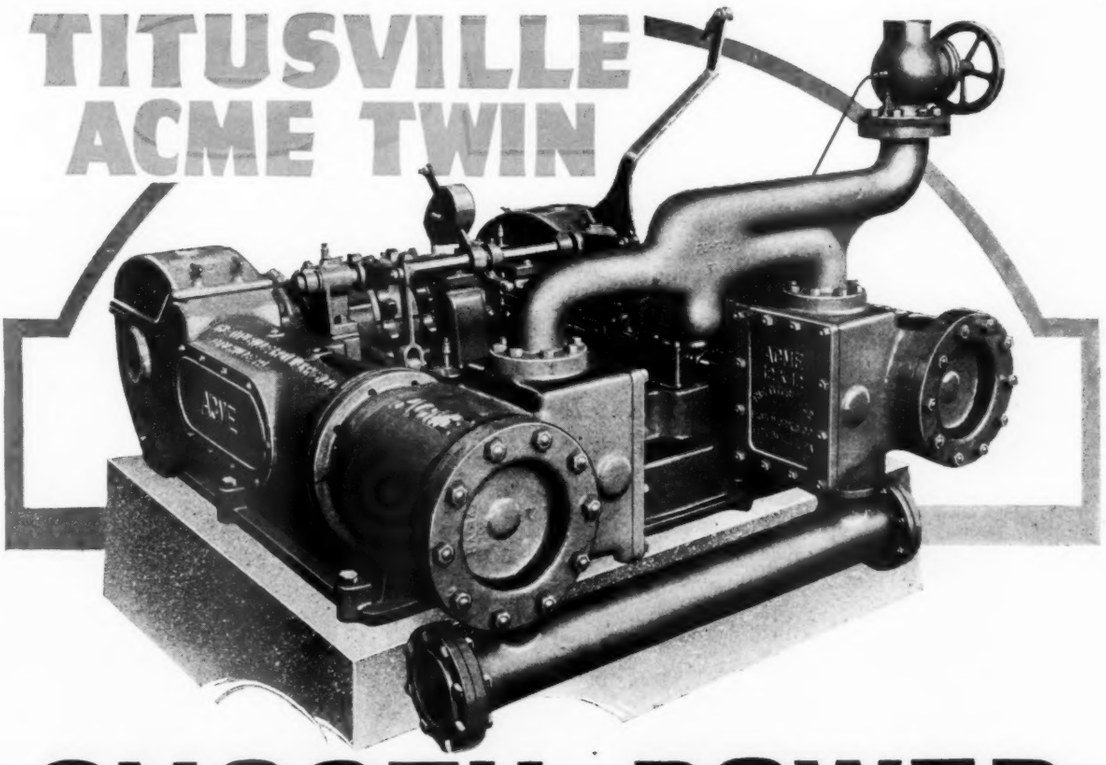
Care in Development

All the important oil and gas fields in the state of California have been and are now being developed with due and careful consideration of underground conditions. The care with which oil bearing horizons have been located has been the objective not only of determining the productive horizons themselves but has been done with the view in mind of excluding by proper shut off the infiltration of top water by proper landing depths the exclusion of dangerous bottom water. The California State Mining Bureau instituted through the co-operation of various California Oil Companies has conducted a very intelligent development program by giving their advice and counsel, in some cases orders to various operators as to the depths at which they should cement water strings in the exclusion of top water and as to what depth they should stop drilling in the exclusion of bottom water. The California State Mining Bureau has always had at its head a geologist with full understanding of the California conditions as well as representatives directly in contact with all the developed and developing fields and their services have been continually at the disposal of producers. Peg models showing the subsurface contours of the various fields constructed to scale are to be found in the local offices of the Mining Bureau situated in the various oil fields where the operators may go and study the underground conditions at any time. It is a tribute to the oil operators of California rather than to any legislative body in the state that the oil and gas section of the California State Mining Bureau was founded and the work done by this body has more than justified the farsightedness of California operators in their desire for a determination of underground conditions to guide them in further operations.

Reservoir Rocks

In the foregoing paragraphs these has been some general discussion of reservoir rocks under the description of stratigraphy of the Tertiary oil-bearing formations of California. The author knows of no case in which oil or gas has occurred in actual cavities in California.

TITUSVILLE ACME TWIN



SMOOTH POWER

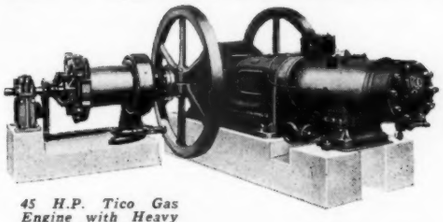
for gas and oil well drilling

To operators for whom the BEST is none too good—we recommend a trial of the Acme Twin Drilling Engine. Actual tests—confirmed by the world-wide experience of users—have proved this type of engine to be superior to all others, for drilling. The ACME Twin insures power PLUS for every purpose, wonderful smoothness of operation, ideal flexibility and ease of control. Its pronounced *adequacy* for every task means lack of strains and resulting longer life.

Its smooth, flexible operation reduces stresses on rotary, drawworks and derrick. Made by the makers of the world-famous TICO Gas Engine.

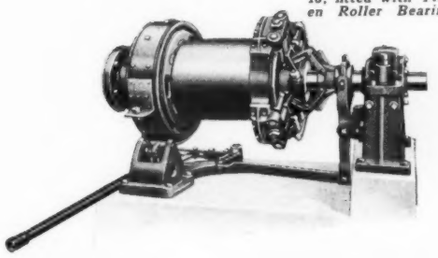
"If CONTINENTAL Sells It, There Is No Better"

THE CONTINENTAL SUPPLY COMPANY
General Offices: St. Louis
Export Office: 74 Trinity Court, New York
London Office: 316-317 Dashwood House, Old Broad St., E. C. 2



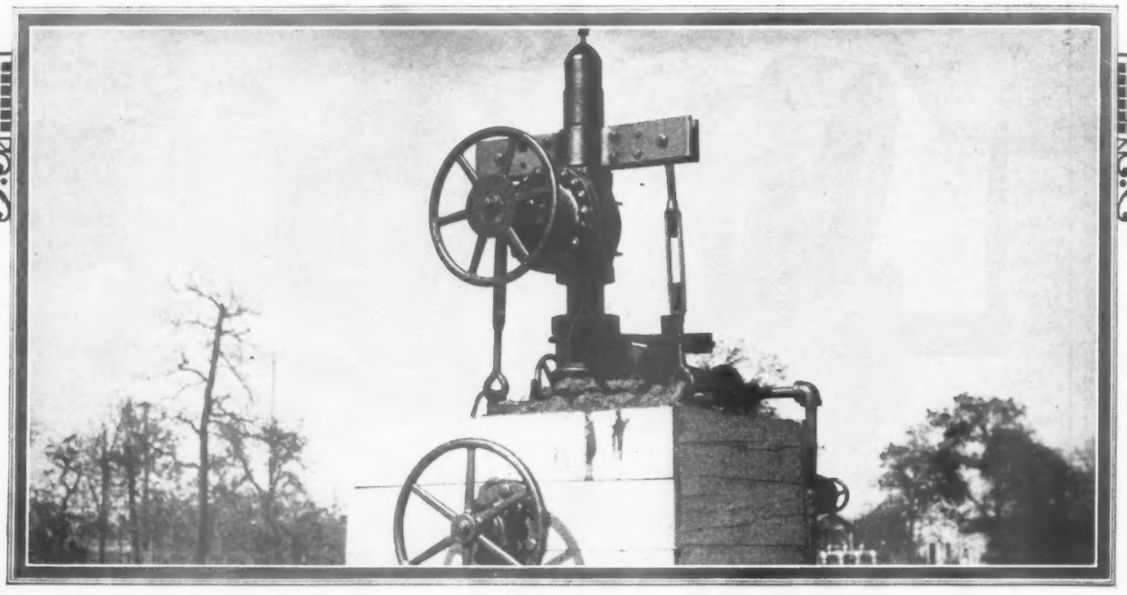
45 H.P. Tico Gas Engine with Heavy Duty Acme Clutch.

Heavy Duty Acme Clutch, 18x18, or 20x 18, fitted with Timken Roller Bearings.



CONTINENTAL

WEST



Prairie Oil & Gas Co. Well, Depew, equipped with Westcott Drilling Gates.

Drilling Gates

Will Hold *Any* Gas Well

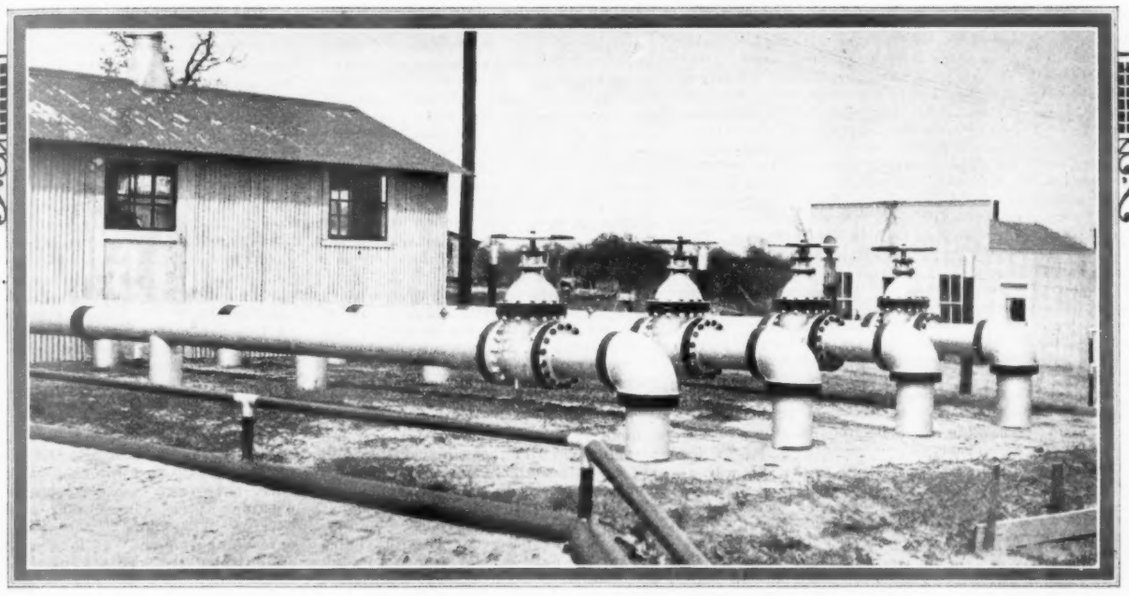
WESTCOTT Steel and Semi-Steel Drilling Gates, designed by oil field engineers especially for handling high-pressure wells,—are unsurpassed for strength both of design and materials. These valves have earned world-wide preference among gas and oil operators, strictly on the basis of their actual performance.

The Special Steel gate, for severe service, is built for 1600 lbs. working pressure and is tested to 3,000 lbs. The same design is offered in semi-steel and steel mounted type.

Unobstructed runway, eliminating damage from flying rocks. Full rocker-type discs with bronze rings. Can be packed under pressure.

CONTI

TCOTT



Pipe Line Valves

Choice of the Leaders

WESTCOTT Pipe Line Valves are as staple today in the Pipe Line field, as is sugar or oatmeal in the national diet. Many of the leading companies have now standardized exclusively on Westcott Valves, in connection with all high pressure lines, both gas and oil.

This is the reward of *specialization.* WESTCOTT alone, of all valve manufacturers, has specialized primarily in the designing and manufacture of high pressure valves exclusively for oil and gas pipe lines. The special requirements for this work have been exhaustively studied by our engineers, and WESTCOTT Valves represent the perfected equipment for this service.

Unobstructed runways. Bronze seat rings. Can be packed under pressure.

Westcott Pipe Line Valves, Oklahoma Natural Gas Co. Measuring Station.

"If CONTINENTAL Sells It, There Is No Better"

THE CONTINENTAL SUPPLY COMPANY

General Offices: St. Louis

Export Office: 74 Trinity Court, New York

London Office: 316-317 Dashwood House, Old Broad St., E. C. 2

NENTAL

The important rock formations containing oil in this State named in order of their highest productivity would naturally be sandstone, sandy shale and shale. It is quite evident that the sandstone due to its great porosity gives up oil and gas more readily than sandy shale or shale.

The average size of sand grains in California oil fields within the producing horizons probably averages about two-tenths of one millimeter. It is a mathematical fact of course, that there is as much interstitial space in finer grained sand as there is in coarser-grained sand. There is, however less adhesion and interference in the coaser sands than in the finer sands and the former consequently produce at a higher rate per day from their inception than do the later due to a freer movement of oil and gas throughout the larger interstitial spaces. The oil and gas bearing sands occur in all gradations from very angular grains poorly sorted and having been subjected to little rounding through transportation by streams, through subangular forms into fairly well rounded grains.

The sandy shales are nothing more or less than sand strata in which the interstitial space of the sand is filled with finer material so that much of the pore space of the sand itself is eliminated as a retainer of oil due to the filling of such space by finer sand and clayl.ke material. Producing horizons of this type naturally give up their oil or gas more slowly and eventually produce less oil per acre than those of the pure sand bodies.

It is probable that some oil and gas is produced although little is expected from clay beds within the Tertiary of California but such production is of little importance economically and not even recognized in the production industry. This phase needs no further discussion. There is an interesting occurrence of oil and gas, however, from which production is derived in the Monterey shale series as pointed out formerly in this paper. Some parts of the Monterey shale occur as highly siliceous flint like formations. In the diastrophic movements by which the folds or faults of the state are developed it is evident that these siliceous members of the Monterey group have been highly fractured and that the oil produced from them occurs in these fracture zones. Such conditions are believed to exist in the Lompoc and part of the Santa Maria Oil Field in Santa Barbara County. It is also interesting to note in connection with this that production from such beds even though not as great initially as that of the sandstone formations has had a considerably longer life than some of the others. This siliceous material when brought to the surface in bailers in the progress of drilling appears to be churned up sand but upon its closer examination the grains consist of fragmentary material from the siliceous portion of the Monterey group without evidence of having been worn by stream transportation, such as is exhibited by water worn sands. The difficulty with which it is drilled is also further evidence that it occurs as a homogenous stratified material.

Migration

There has been much in the current literature of late years in regard to the migration and accumulation of oil and gas. Many of the agencies tending to generate oil and gas from organic shales must be the same agencies which cause the oil and gas to migrate from the shales to the point of accumulation. Pressure and heat developed by sediments superimposed upon the organic shales are necessarily the two main agencies in causing the organic shale to give up hydrocarbon material which may easily move from the shale to occupy points of less resistance. It is the author's opinion that the main factor in the generation of oil from organic shales is merely the squeezing out process of the hydrocarbon material at proper conditions of temperature caused by increased load on the shales themselves. This increased load is due to the weight of superimposed sediments as well as the diastrophic earth movements tending to exert added pressure on the rock formations. Various scientists have worked on the problem of shrinkage of pore space of sedimentary rocks caused by superimposed formations and one reliable worker gives the following data. Loosely deposited shales have a measured porosity in excess of 50 per cent at the surface. Such porosity with 6,000 feet of superimposed sediments may be reduced to as little as 10 per cent. The squeezing effect of the loading and diastrophic processes must have a tendency to drive from shales some of the mobile organic material which would be generated into hydrocarbons under this process, at proper temperatures. Such compression of the rocks combined with process of development of synclines and anticlines would naturally cause the movement of hydrocarbon material content into sand horizons having greater pore space.

Earth temperatures as studied whereever possible in deep mines and through the emission of deepseated springs have been shown to be extremely variable. It has been determined however, that at Paris, France, about 48 degrees north latitude there is a constant annual temperature of 11.8 Centigrade at a depth of 30 meters. It is further estimated that for every additional 30 meters in depth the terrestrial temperature increases by 1 degree Centigrade. It is probable that this constant temperature should be more or less correct throughout the temperature zone. Using the above figures it is estimated at a depth of 6,000 feet (which at least we are certain some of the California organic shales occupy) the terrestrial temperatures would be in excess of 70 degrees Centigrade or approximately 160 degrees Fahrenheit. At a depth of less than 9,000 feet the terrestrial temperature should be over the boiling point. Oil from some of the deep wells in California, that is from 4,000 to 6,000 feet is being produced at temperatures ranging from 80 to 130 degrees Fahrenheit. No doubt much of the original heat is lost by expansion of gas in the flowing process.

It is not the intention of the author here to discuss in detail the origin and accumulation of oil and gas for this could be made a treatise of great length and should involve many of the attending physical processes accompanying the generation of oil and gas by heat and pressure.

Terminology

Terminology commonly used in oil field practice today includes the terms "rock pressure," "gas pressure" and "hydrostatic head," the last of course meaning the pressure created by a given head of water. The above pressures are referred to as the process by which oil and gas are flowed to the surface of a well. If we but hesitate a moment here to roughly analyze the cause of pressure on an oil and gas zone we draw the following conclusions. First, it is a fact that the oil and gas-bearing formation itself existed prior to the accumulation of any of the oil and gas. This rock formation was composed of sedimentary material in its proper state of balance and exerted its entire gravity pressure regardless of any fluid content. Such would be the case whether or not any of its members were occupied by water. The fluid occupying the pore space of any of the sedimentary rocks is a secondary matter and is not subjected to the rock pressure itself but only to its own hydrostatic head. This paragraph is included at this place because of the fact that many connected with the oil production industry are under the belief that the pressure due to weight of the rock formation is meant when referring to rock pressure.

Having a condition of sedimentary rocks already in perfect state of equilibrium we can picture the generation and accumulation of oil and gas in some of its members. The oil and gas in the process of generation is moving toward the point of least pressure and in so doing it naturally moves upward in the column until it may reach strata of impervious material through which it does not easily penetrate. At such point the minute globules of gas and oil or gas alone will move along the bedding planes until it finds the uppermost point to which it may proceed. This of course is near the axis of some anticline or upper member of some favorable structure and under an impervious clay or shale material. Such process continued for geological ages has eventually culminated in the accumulation of large amounts of oil and gas as found today in oil bearing structures. This process of generation and migration and accumulation of oil and gas at least in some fields, is doubtless going on today just as it has gone on from the beginning. The migrating oil and gas from the organic shale must no doubt in nearly all, if not all cases find its way through water or along with water occupying the pore spaces of the material through which it migrates in its path to the point of accumulation. The process is inconceivably slow and the physical result is merely in readjustment through difference in gravity between the hydrocarbon material and the water. In the cases where there are several oil and gas bearing zones in the same field all lying above the organic members from which the oil and gas were generated it is apparent that the following process is responsible for such accumulation. The lowermost accumulation has evidently developed to a point where the pressure has become so great that part of the oil and gas has forced its way through shales impervious to the accumulation under a lower pressure and has migrated on upward, eventually being confined under other shales at lower pressures. A repetition of this process might develop so that in a given field several oil and gas zones, one above the other, have been accumulated from the same source.

Further it is evident that in the process of this migration the oil and gas in the uppermost accumulation have suffered the greatest oxidation through having moved the greatest distance and it is quite natural that in the development of a field we usually find the highest gravity oil in the lowest horizons where they have been subjected to least oxidation.

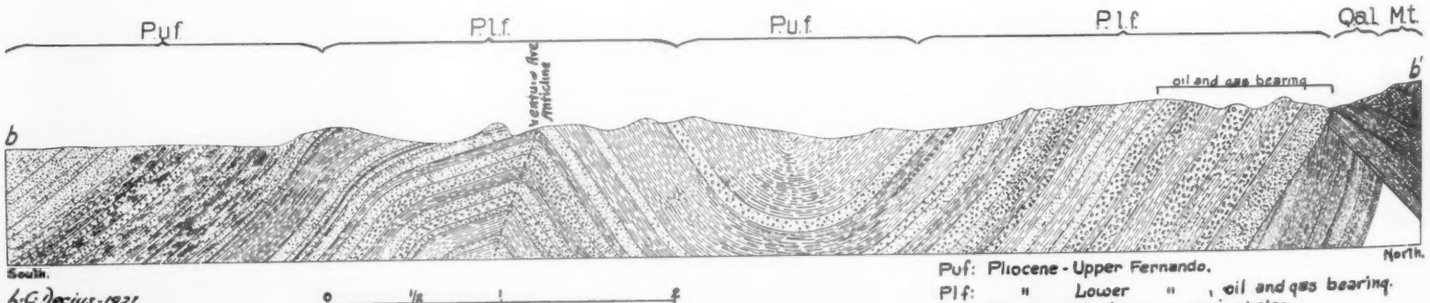
Gas Pressure and Oil Recovery

Recorded gas pressure in oil and gas wells is a measure of the state of compression under which the gas exists in the sand. Such pressure is an indication of ultimate recovery of a well only in so far as concerns other given factors. For instance an oil and gas well producing from a sand 10 feet in thickness (other conditions being equal should produce approximate one-half as much oil and gas as a well producing from a sand 20 feet in thickness. Gas pressure from a 10-foot sand should be the same as gas pressure from a 20-foot sand in the event that the gas in these two sands is under the same state of compression. It has been pointed out in the foregoing paragraphs of this paper that the only recognizable feature contributing to the pressure on an oil and gas sand is seen in the hydrostatic column exerting its weight against the oil and gas trapped in an anticline or faulted monocline or even in an open monocline. The author here pleads lack of knowledge of pressures recorded in oil or gas wells in California which pressures have been in excess of a possible existing water column that might be exerting its weight and consequent pressure on the oil and gas bearing horizon from which the gas pressure has been measured.

As a concrete example of the production of gas compared with its existing condition in the oil and gas horizon the following facts are evident. In a certain oil field in California the general analysis of whose gas is as follows: Methane—83 per cent, Ethane—12 per cent and lower hydrocarbons 5 per cent, the oil and gas are being produced from an average depth of 5,000 feet. The greatest temperature of oil recorded at the surface is about 130 degrees Fahrenheit which temperature cannot be less than the temperature in the oil sand and also which temperature is above the critical temperature of the various gases noted. We are certain then that these gases would occur as gas in the oil and gas horizon even at definite pressure. It is further interesting to note, and this point is sometimes overlooked by those in the producing industry, that the gas output of a well is gauged at the surface under atmospheric pressure or nearly so. Now at an average depth of 5,000 feet the hydrostatic head on a well in this particular field will exert at least 2,000 pounds per square inch pressure on the oil and gas in the sand at 5,000 feet depth. Having the gas above described

GEOLOGIC SECTION · EAST END · VENTURA AVE. OIL FIELD.

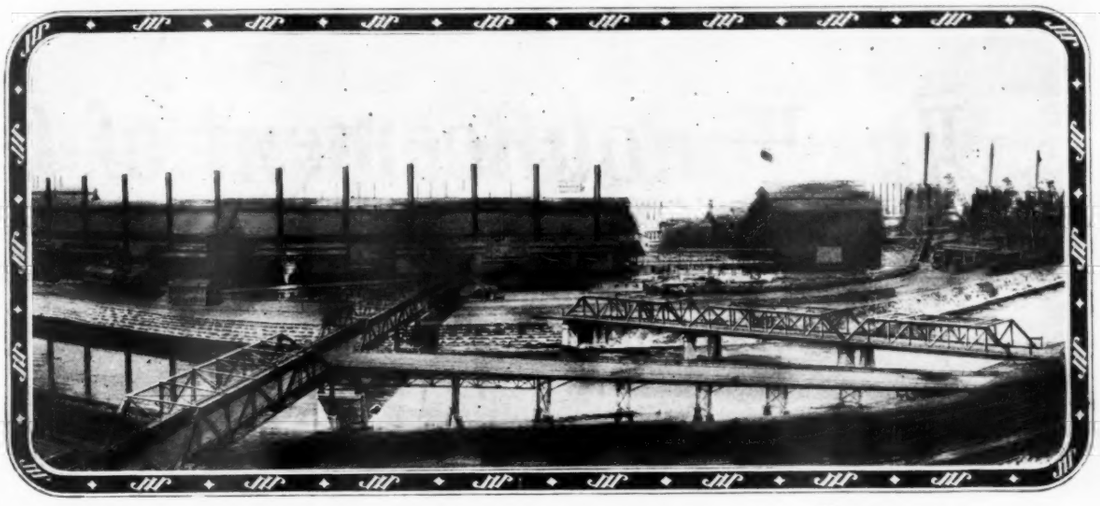
Plate 4



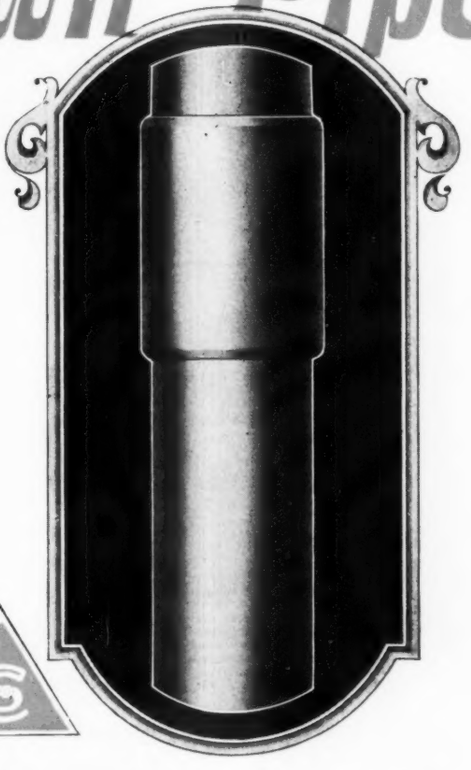
A.G. Decius - 1921.

0 ½ 1 2
scale in miles

Puf: Pliocene - Upper Fernando.
Plf: " Lower " , oil and gas bearing.
Mt. Miocene - Monterey, organic shales.
Qal. Quaternary alluvium.



Youngstown Pipe IS good PIPE



Youngstown Pipe is made by America's largest independent manufacturer of tubular steel products. From ore to finished pipe, every step is conducted by this company. Selected steel, advanced designs and rigid inspections insure the quality that for more than 20 years has given satisfaction in every important oil field in the world.

A complete line of Casing, Tubing, Drill Pipe and Line Pipe meets every Oil Industry need.

Range of sizes—⅛" to 20" OD, Lapweld, Buttweld, Seamless.

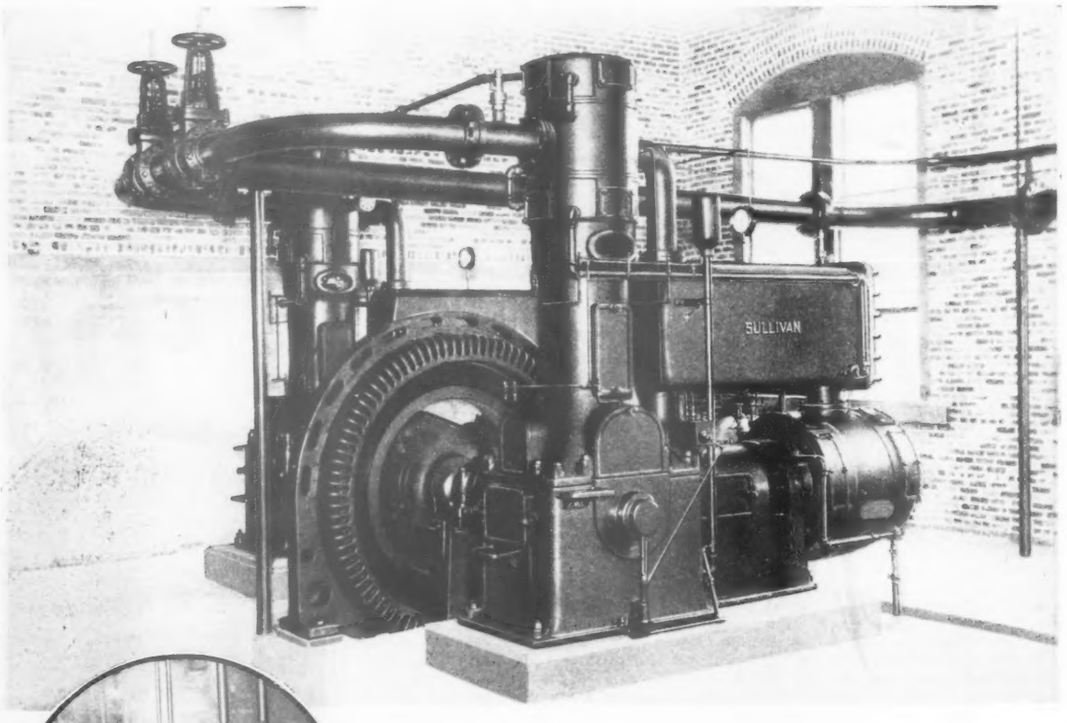
"If CONTINENTAL Sells It, There Is No Better"

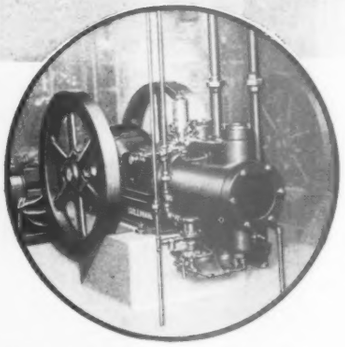
THE CONTINENTAL SUPPLY CO.
General Offices: St. Louis
Export Office: 74 Trinity Court, New York
London Office: 316-317 Dashwood House, Old Broad St., E. C. 2

CONTINENTAL

SULLIVAN AIR

An Announcement of Great





Above, "WG-6" belt driven, single stage compressor, built in capacities from 68 to 513 cu. ft. Below, one of two "WN-4" Twin Angle Compounds, direct motor driven, 3100 cu. ft. each, at the Republic Iron & Steel Co., Bessemer, Alabama.

Sullivan Air Compressors stand for a continuous, trouble-free air supply. They are built to the highest engineering standards and embody the most up-to-date practice in design and construction.

Wafer Automatic Air Valves, Multi-Step Load Control, effective cooling systems and positive, force feed lubrication help to make Sullivan Air Power service efficient and dependable. A wide range of capacities, from 68 to 3700 cu. ft. per min. are available. Drive is by belt, or by direct connection to electric motor or oil engine.

Back of Sullivan Compressors are two great Sullivan Factories, where every step in the manufacture of Sullivan Machinery takes place, including designing, pattern making, casting, machining and assembling. At your service is the Sullivan Engineering Department with its 30 years' accumulated knowledge and experience in building and using air power machines.

Truly there is reason in the saying "You Can Depend On Sullivan Air Power."

Write for Catalogs.

CONTIN

POWER SERVICE

Interest to the Oil Industry

The Continental Supply Company announces the conclusion of an agreement with the Sullivan Machinery Company for the sale of Sullivan Air Compressors, both stationary and portable, and of Sullivan "Turbinair" and Electric Portable Hoists, to the Oil Industry, in the Mid-Continent Territory.

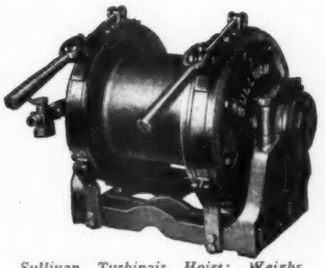
Sullivan equipment and spare parts will be carried in stock at Continental Supply stores.

Sullivan engineers will be available to assist clients in working out compressor and hoisting jobs.

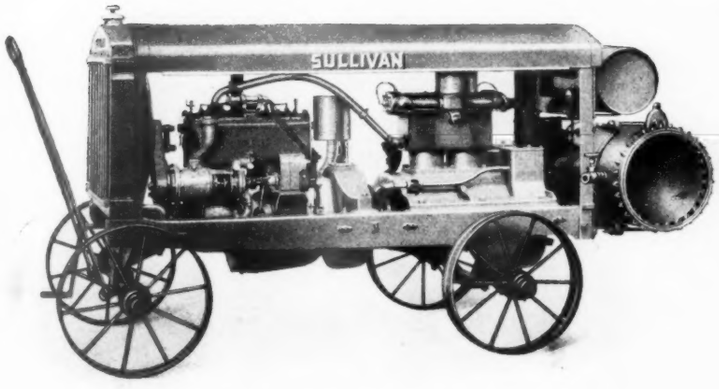
Thus the oil industry will benefit doubly, first, from the engineering experience and manufacturing excellence represented in Sullivan air power equipment, and second, from the service which Continental will give in making this equipment readily available in the field.

"If CONTINENTAL Sells It, There Is No Better"

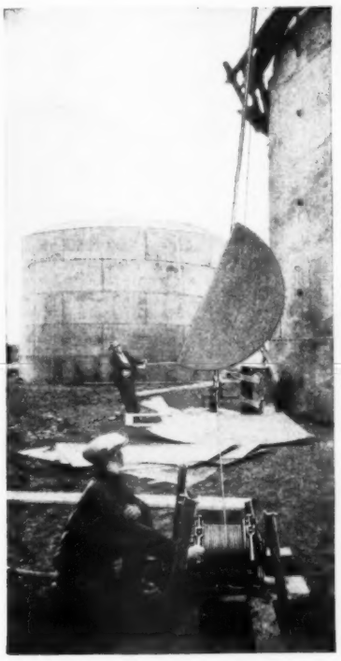
CONTINENTAL SUPPLY COMPANY
SULLIVAN MACHINERY COMPANY



Sullivan Turbinair Hoist: Weighs only 345 lbs., but lifts a ton. Catalog 76-F.



Sullivan "WK-314," 310 ft. Portable Compressor; Sullivan Portables are available in 110, 160, 220 and 310 ft. models, for running your hoists, riveters, and other air tools. They are mounted on steel wheels, rubber-tired trailer trucks, skids, or your own truck. Catalog 83-D.



Sullivan Hoist swinging up a roof plate, Marland Refining Co., Ponca City, Okla. (Graver Corporation, Contractors.)

NENTAL

and the conditions as above recorded, that is a temperature of 130 degrees Fahrenheit and a pressure of 2,000 pounds per square inch we therefore find that 1,000 cubic feet of gas as gauged at the surface under a normal temperature of 70 degrees Fahrenheit and 15 pounds per square inch pressure would be reduced to 9 cubic feet under the conditions existing in the oil and gas sand. It is therefore not difficult to prove that the pore space in the oil and gas bearing horizon is more than ample to account for the total volume of oil and gas ultimately produced in a given field. In other words under the above conditions the total volume of gas produced, as gauged at the surface is reduced in cubic content one hundred times when subjected to the pressure maintaining in the oil and gas sand.

Gas and Oil in Same Sand

There have been numerous articles in the current literature of late as regards the status of accumulation of oil and gas associated in the same sand. It is the opinion of most writers that some of the gas produced from oil and gas fields occurs in the sand as gas not associated with or absorbed in the oil. This may or may not be the fact. It is entirely possible and seems even probable, when we consider the conditions of accumulations of gas deposits, that oil and gas being produced from the same horizon are found in this horizon in very close association and it is more than possible that the gas is all absorbed in the oil. Experimental work tends to show that 1 bbl. of oil will absorb at least 450 cubic feet of gas at a pressure of 250 pounds per square inch (these are conditions in a certain California field). Further when we consider the fact that on an average not more than 20 per cent of the oil from a sand is produced by present methods we also admit the fact the remaining 80 per cent unproduced is to a large degree depleted of its absorbed gas. It seems therefore entirely reasonable to assume that all the gas in the horizon is absorbed in the oil prior to its production. At least I know of no instance where gas produced by oil and gas wells has been in quantities in excess of what might be expected from the entire oil bearing horizon.

There are in the California fields many horizons from which gas alone is produced at some point or other. However, in these fields there are underlying oil horizons. The gas horizons in such fields are probably the result of an accumulation of the lower hydrocarbons which have passed through shale beds responsible for the accumulation of the heavy hydrocarbons and liquid oil, and have accumulated at points of least resistance higher in the stratigraphic column under other overlying shale beds. The author has in mind at this time no occurrence of gas unassociated with oil occurring below the oil horizon.

It has been shown that gas pressure recorded at the surface is no criterion as to the thickness of oil and gas producing horizon into which the well has been drilled. The recorded pressure from a 10-foot sand under a given natural pressure will manifest itself to the same degree as the recorded pressure from a 20-foot sand under the same natural pressure will manifest itself. Under these like conditions of pressure with different thicknesses of sand there will be a definite decline curve established in each case. The volume output from the 10-foot sand will be exhausted at a different rate of speed than the volume to come from the 20-foot sand.

It is apparent the principal if not sole motivating force tending to force oil and gas from a producing horizon is the expansive force of the gas alone. The underground conditions developed by drilling a well into an oil and gas bearing sand under high pressure can probably be better pictured mentally as a shrinkage process of the fluid and gas under high pressure toward the low pressure area created by the well. In this shrinkage process it is natural that the content nearest the well is that produced first. The gas held in a compressed state is made mobile by a well penetrating the sand, and so with the pressure released must pass through the naturally inert oil on its way to the perforations of the well. In such process the gas must drive before it much of the oil lying near the well and it is for this reason only that oil itself is carried to the surface. A perfect gas in expanding describes an hyperbola in its rate of expansion. Petroleum engineers estimating the rate of production and quantity of oil from a well have come to use almost solely the family decline curve of a group of wells which itself usually develops a modified and imperfect hyperbola. The modification is an expression of the resistance offered to the flow of oil by friction against the sand grains and against the walls of the well. Were it not for the factors tending to resist the flow in a well due to expansion of gas it seems apparent that the production decline curve of each well would become an perfect hyperbola. The factors tending to resist the flow of oil from the sand are friction in the movement of the oil and gas against the sand and against the wells of the well, possibly some drop in viscosity due to decreased temperature caused by the expanding gas and capillarity or the tendency of the oil and gas to adhere to material with which it comes in contact.

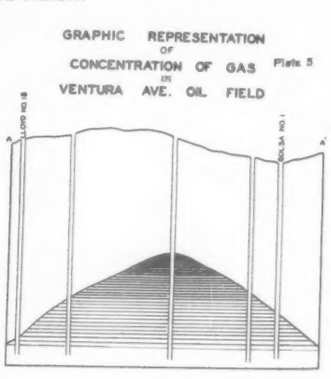


Plate 5 is an ideal transverse section across the Ventura Avenue Oil Field and when studied in conjunction with Plate 2 represents the underground conditions of concentration or compression of gas in the oil bearing horizons. The attempt has been made in Plate 4 to show graphically by more ink near the crest of the anticline that the gas-oil ratio of production in this area is higher than on the edge of the field. Whether the gas pressure is considerably higher in the crest of the anticline or not is a debatable question. The fact remains however from the examination of Plate 2 that the amount of gas per barrel of oil produced by wells that have penetrated near the crest of the anticline is far greater in proportion than the amount of gas produced per barrel of oil by wells drilled down the flanks of the anticline. It is the opinion of the author that this gas-oil ratio condition exists partly due to the fact that pressures are higher near the crest of the anticline and partly due to improper tubing of the wells. The fact that some of the wells are improperly tubed is not entirely the fault of the drilling departments of the operating companies. Pressures in the Ventura Field run quite high and when drilling under such pressures at depths of 5,000 or 6,000 feet it is sometimes impossible to complete the well as desired. Many of the wells come in as producers while still being drilled and in many cases the drill pipe is necessarily left in the hole, making it impossible to tube the well. It is probable, however, that in case such wells were completed with tubing placed well down toward the bottom of the oil producing horizon the gas-oil ratios would be considerably lower with the result that ultimate recovery of oil from the field would be greater. It has been pointed out that the motivating force of the expanding gas is the main reason for the production of oil otherwise inert. It is further apparent that if a well is drilled into an oil and gas horizon at a depth of 4,000 feet and the tubing is hung in the hole at a depth of 3,000 feet much more oil will be bypassed by the expanding gas than if the bottom of this tubing were hung near the bottom of the oil measures thereby forcing all the gas to move downward through the inert oil before it might enter the tubing and thence be produced at the mouth of the well. It would simply constitute a method of keeping the gas in contact with the oil for a longer time than under conditions above described where tubing is not placed deep enough.

Future Outlook

The source of the natural gas supply for the future of California may be divided into three groups, first, the gas to come from present producing oil and gas fields, second the gas to come from oil and gas fields to be discovered in the future and third, gas to be developed in fields which may possibly produce only gas.

Gas to be produced by present oil and gas fields must naturally come from the present known proved acreage. It is the author's opinion that the future production of oil from California from the present proved acreage under present production methods including application of the air and gas lifts and better pumping devices which are coming into use at this time will total approximately 2,000,000,000 bbls. Less than one-half of this amount of oil will be accompanied by gas in sufficient amounts to be commercially utilized. Oil and gas wells in the state today produce anywhere from 200 or 300 cubic feet per barrel to 15,000 or 20,000 cubic feet per barrel. Wells producing by natural flow will perhaps average somewhere in the neighborhood of 1,000 or 1,200 cubic feet per barrel. As indicated above probably less than one-half of the 2,000,000,000 bbls. estimated as California's future oil production will be attended by gas in sufficient amount to be saved commercially. Therefore, it would seem roughly that with an average of 1,000 cubic feet of gas per barrel of oil from flowing wells the total gas output of California for the future within the present proved reserves will total somewhere in the neighborhood of 1,000,000,000,000 cubic feet.

Within the author's limited access to comparative values between natural gas and manufactured gas for industrial purposes it is apparent that dry gas marketed from oil and gas producing wells is at least 25 per cent more effective in that it contains about 25 per cent more heat value than gas manufactured in industrial plants and delivered for domestic use. Natural gas from oil and gas producing fields within the state is utilized to the fullest possible extent under present economic conditions. With the sporadic development in the last few years of highly prolific gas fields in California it has been impossible to market the entire gas output both because of lack of facilities and because of an overproduction of gas which could find no market. The future consumption of natural gas in California has a brighter outlook from an economic viewpoint. Many gas lines are already constructed and more are under construction at this time. New fields to be found in this state are almost certain to be located within reasonable distances of the already existing gas pipe lines. The output of gas from any new fields, therefore, can be almost immediately turned into the lines and it is believed that a far greater proportion of the gas to be found in future fields will be used as fuel for industrial and domestic purposes than has been in the past.

Additional Fields

Any estimates of the quantities of gas to be obtained from possible fields to be discovered in the future is absurd. The statement is made in foregoing paragraphs, however, that it would seem unreasonable not to expect the discovery of more oil and gas fields of first magnitude in California. By first magnitude is meant fields of the type of Santa Fe Springs, Long Beach, Ventura Avenue, Inglewood, Huntington Beach and many others. These fields producing large quantities of gas are usually producing from deep sands. Fields of first magnitude have an ultimate production of oil ranging from 100,000,000 bbls. to in some cases more than 300,000,000 bbls. It is reasonable to expect an average gas production of 1,000 cubic feet per barrel of oil from such fields. An average field of first magnitude therefore should be expected to produce somewhere in the neighborhood of 200,000,000,000 cubic feet of gas.

There are no developed gas fields in California producing gas alone. The development of such fields will depend on, first their possible existence and discovery and second on the price offered for such gas by industrial gas companies. So far as can be determined at this time from geological data it is apparent that gas accumulations of economic importance unaccompanied by oil may exist. In prospecting for oil in the region of Tulare Lake, Kings County, in the San Joaquin Valley, gas has been found under high pressure by wells which could have produced several million cubic feet per day. Failure to find oil by these wells, however, and the lack of need for additional gas in that vicinity has contributed to the financial failure of the enterprise to date.

Discovery of enormous gas production in the so-called Buttonwillow District adjacent to Sunset Midway Oil Fields casts a very favorable outlook for possible gas production when the gas from the oil producing horizons in that district has fallen below present demands. The Buttonwillow gas carries no ethane, about 30 per cent methane and 65 per cent nitrogen. The methane content is unusually low for California petroleum gas and the nitrogen content is extremely high. It is reasonably certain, however, that middle Miocene shales from which the oil of the Sunset Midway Fields is derived underlie the Buttonwillow District and it therefore appears, in the absence of any known carbonaceous material in the sediments underlying Buttonwillow, that the gas discovered there is of petroleum origin. It is entirely probable that oil production may be found in later prospecting in this same district. One well drilled in Buttonwillow District by the American Oil Field in 1921 is estimated to have produced from 60,000,000 to 80,000,000 cubic feet of gas daily. The Milham Exploration Co.'s well in this same district blew out and caught fire in 1926. This well is estimated to have produced probably 50,000,000 cubic feet daily. Both these wells soon sanded up and now stand dormant.

Gas in smaller quantities has been discovered under the alluvium of the San Joaquin Valley, and has definitely been determined as marsh gas. The heat value of such gas has not been recorded so far as the author knows and it is therefore unwise to judge whether or not these discoveries will ever have commercial value.

The gas wells discovered in the Buttonwillow district and in the region of Tulare Lake in San Joaquin Valley constitute the only important discoveries presaging possible future development of gas fields and it seems beyond reasonable doubt that the gas in each of these localities is of petroleum origin. Thus the future gas industry of California so far as present knowledge goes will apparently be very closely allied to the petroleum industry.

Technical men within the petroleum industry in California are at present devoting much time and work toward the conversation of California gas for various reasons. They realize that the lower the gas-oil ratio of a given well can be made the greater the production that can be expected from this same well under flowing methods. This phase of work has at this time passed the experimental stage and is being practically applied, principally through improved tubing methods. That it is the desire of the California petroleum producers to conserve gas and to market all gas possible under prevailing economic conditions is now fully recognized, and the industry and community of the state is apparently assured of the fullest possible values to be derived from gas produced in the various oil fields.

NEW

GOODALL
Semi-Metallic
MANIFOLD HOSE

An Improvement for Rotary Drilling

This manifold Hose has been perfected to provide a flexible connection between standpipe and pumps, in place of the rigid connection being used by many Rotary Drillers.

Use of this flexible connection will bring about (1) less strain on the pumps, (2) less vibration, which means fewer loose connections, (3) less danger from derrick's taking up too much swaying motion, (4) less noise.

This hose possesses all of the outstanding merits of Goodall Semi-Metallic Rotary Hose—including ability to stand highest pressures, exceptional flexibility, and capacity to withstand hardest usage.

"If CONTINENTAL Sells It, There Is No Better"

THE CONTINENTAL SUPPLY CO.

General Offices: St. Louis

Export Office: 74 Trinity Court, New York

London Office: 316-317 Dashwood House, Old Broad St., E. C. 2.

CONTINENTAL

Gas Regulator Design and Operation

Various Problems Confronting Companies in This Connection Discussed and Methods of Solving Explained

By T. H. Kerr
Superintendent Meter Department, The Ohio Fuel Gas Co.

In our several years of operation of regulators for rural domestic consumers, we have found that generally the average rural consumer, who knows little or nothing about the theory of gas pressure regulation, is better satisfied if his gas is controlled by a lever weighted regulator rather than one of the spring loaded variety. He insists on having something to get his hands on in the form of a handle. The lever affords him this pleasure.

Very often a regulator of this type becomes frozen during the night time, when very little, if any, gas is being used and the small amount that is used, is practically constant, so that the regulator valve remains in one position for a long period of time. The small quantity of gas is insufficient to conduct to the regulator the heat of the ground. After the farmer has pumped the regulator, as he calls it, a few times and started his winter breakfast, the added flow of gas keeps the regulator operating until the increased temperature of the daylight hours assists sufficiently to keep it from freezing for another day.

Definite Specifications

Regulators of this kind are usually purchased on very definite specifications as to inlet and outlet pressures. The manufacturers, in furnishing the regulators for higher inlet pressures, usually provide them with very much smaller valve openings, than would be furnished on similar regulators working on lower inlet pressure. The companies using the regulators are not so careful in making exchanges and very often regulators which were purchased for use on high inlet pressures are connected on services where the inlet pressure is very much different, and the valve area is entirely unsuited to the purpose for which it is used.

Regulators of this type having metal seats and metal valves, function reasonably well when gas is being used so that they can operate as a regulating valve, but many times they fail utterly to close off the very small flow during hours of minimum consumption and gas is permitted to escape through the safety valve. When companies have great numbers of consumers of this kind, the total amount of gas lost in this manner is very appreciable. For this reason we inaugurated a program some three of four years ago, whereby all such regulators were equipped with the same standard size valve seats and the valve itself fitted with one-eighth-inch paranite rubber face. At the same time the valves were equipped with a low pressure shut off so that the consumer was protected in the event of temporary failure of the gas supply.

Usual Procedure

The usual program in this connection is to install a high pressure regulator having a range of from 300 pounds to 10 pounds, so that the rubber seat in the low pressure one would not be required to work against the full line pressure. We are of the opinion however that where the inlet pressure does not exceed 100 pounds that this is not entirely necessary, although perhaps it does increase the life of the rubber faced valve.

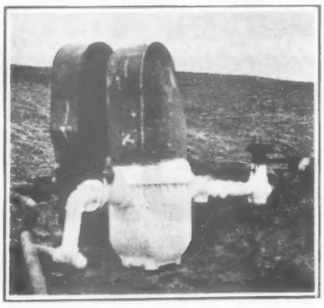


Figure 1

In attempting to control the pressure of gas used for drilling wells, we encountered a great deal of difficulty. Very often gas for this purpose is taken from the top of new wells having a rock pressure of from 500 pounds to 1,200 pounds, and at other times it is taken directly from high pressure lines having a pressure as high as 500 pounds.

We had very little success in the use of 2-pound balanced valve regulators for this purpose. We were continually confronted with the gas escaping through the regulators and to the atmosphere through the safety valves provided to protect the meter against excessive pressure during periods of shut down or non-use of gas. We had no satisfactory control of this pressure until we secured 2-inch regulators with needle valve seats having a diameter of approximately five-eighths of an inch and the tapered valve suspended loosely on the valve stem, so that it was self-centering on the seat. We have had such satisfactory operation of this type of regulator that all of our 100 balanced valve regulators have been changed over to this type. We also have had very satisfactory results from the use of this type of regulator for controlling the pressure to some of our small town plants. For drilling well service where the inlet pressure does not exceed 500 pounds, one regulator is usually sufficient to reduce the pressure to an average of 10 pounds. It has not been found necessary to apply heat to these regulators, except in cases where it is necessary to use two in series to reduce pressure of over 500 pounds to less than 50 pounds. Very often the refrigerating effect caused by the sudden expansion of the gas through such a wide range of pressure causes the regulator, the meter and service line to be completely coated with ice for a considerable distance from the tap or regulator. The accompanying picture, Figure No. 1, illustrates this point very nicely. The outfit shown, like many others, functioned perfectly throughout the entire drilling of the 3,000-feet well being served.

Refrigerating Effect

The refrigerating effect of a sudden reduction in pressure and the resultant expansion of any gas is an engineering problem demanding careful consideration. In order to prevent large capacity regulators from freezing when handling large volumes of gas, or a smaller quantity of gas through a wide range of pressures, it is necessary to provide some means of supplying the heat, to be absorbed by the gas. The absorption of heat may be distributed over a large area where it can be absorbed from the atmosphere or sufficient heat provided to prevent the formation of ice in sufficient quantity to interfere with the free movement of the regulator valves. This heat may be supplied in several different ways. Where a small amount of gas is being controlled, heat may be applied to the pipe line on the inlet side of the regulator in sufficient quantity to warm the flowing stream of gas, so that refrigeration caused by the drop in pressure will be offset to a sufficient degree that ice will not be formed. If, however, the quantity of gas being handled is large, this method becomes not only difficult, but expensive, on account of the amount of heat required. If the regulator in question has periods of comparative idleness, during which very little gas is passed, there is no satisfactory means of conducting the heat to the valve and very often ice will be formed in sufficient quantity to interfere with the operation, even though the gas may be quite warm a few feet distant on the inlet side. In the use of regulators, as ordinarily made by the manufacturers, it is very difficult to apply heat to the outside of the valve body in a sufficient quantity to influence the condition of the valve. The accompanying cut, Figure No. 2, illustrates the path through which heat so applied must travel in order to reach the valve seat. Heat which is conducted through the walls of the regulator to the inside is radiated to the gas which has been discharged from the valve and it is immediately conducted away from the valve rather than to it. The only heat which can reach the valve is the relatively small portion of the total heat applied which is conducted through the iron.

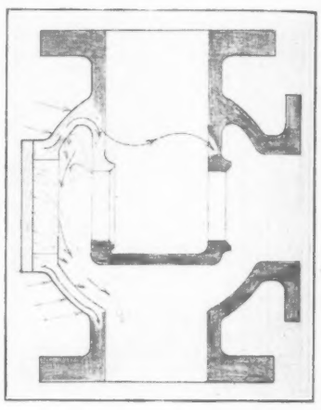


Figure 2

Experience Near Columbus

At a point a few miles east of Columbus an 8-inch regulator was installed about 1914 and because of the difficulty experienced in keeping it in continuous, dependable operation, reducing the gas from a pressure of approximately 200

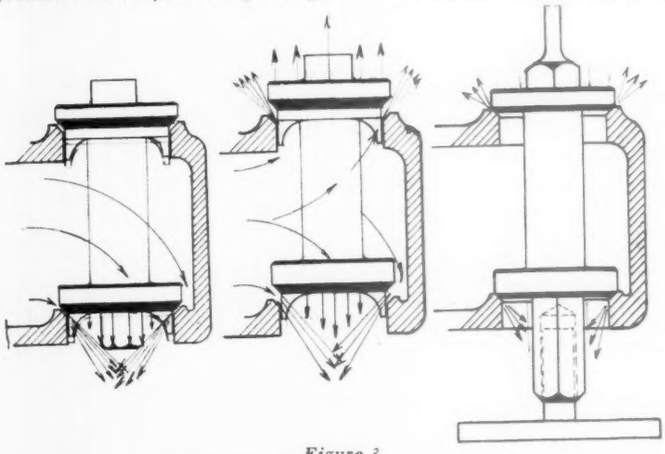


Figure 3

Conventional Type
Lower Valve only open. Unbalanced. *Both Valves open. Partially balanced.* *Nonfreeze Type Both Valves open same. Fully balanced.*

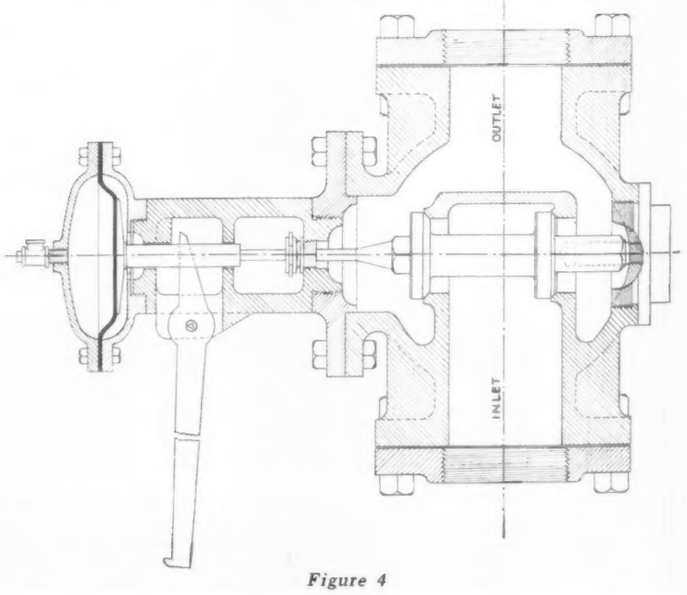


Figure 4

Tnemecol
PIPE LINE PAINT
for longer-lived lines

Maintenance of pipe lines is one of the heaviest loads carried by gas or oil operators. Anything that prolongs the life of pipe lines will bring tremendous economies.

TNEMECOL Pipe Line Paint, like the same manufacturer's Tnemec Paint, is a paint of unrivalled toughness and durability especially designed to protect underground pipe lines.

TNEMECOL is water-proof, acid-proof and alkali-proof. It gives a glossy, elastic coat that will not crack, rub, peel or scale off. It is applied with ease and spreads over 300 to 400 square feet per gallon.

Sold by all CONTINENTAL stores, in any quantity from a barrel to a carload.

TNEMEC Ideal for Galvanized Iron

Most paints will not adhere to galvanized iron, when it is new. When it is rusty, ordinary paint will not hold unless the rust is first removed.

TNEMEC has proved an ideal paint for galvanized iron. Its Cement pigment has certain natural qualities that overcome both of these difficulties. Rust need not be removed, as the Cement in TNEMEC Paint absorbs and neutralizes rust. A trial will convince.

TNEMEC Floor Paint

TNEMEC Floor Paint is a super-durable floor paint, which we can highly recommend for all kinds of floors, whether wood, cement, or of special compositions. It is especially recommended for cement floors. Unpainted cement floors shed a fine dust, soak up oil and grease, deteriorate and wear. TNEMEC Floor Paint gives full protection against all these evils. One gallon gives two coats for 250 to 300 square feet of floor.

"If CONTINENTAL Sells It, There Is No Better"

A galvanized iron hangar painted with Tnemec Paint.

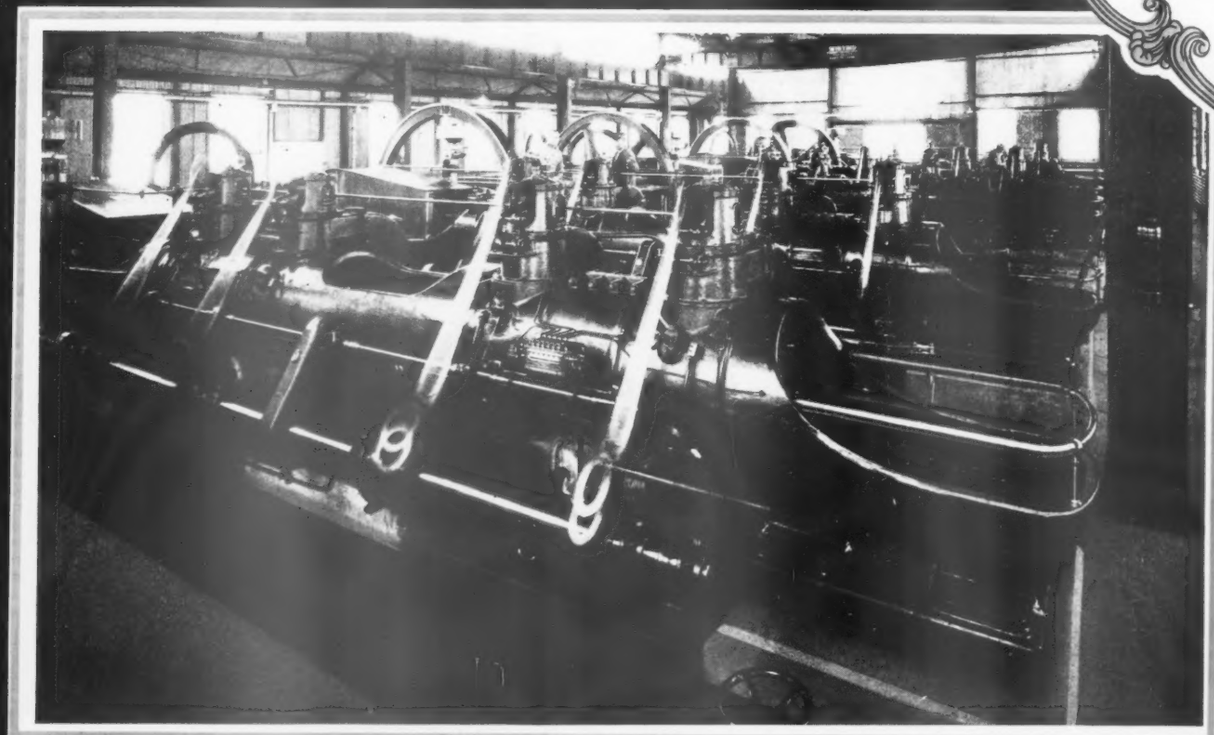
Applying Tnemec Floor Paint in a Mid-Continent plant of a leading refining company.

THE CONTINENTAL SUPPLY CO.
General Offices: St. Louis
Export Office: 74 Trinity Court, New York
London Office: 316-317 Dashwood House, Old Broad St., E. C. 2

CONTINENTAL

COOPER

Cooper sizes are 170, 380 and 100



Empire Will Use

The Empire Natural Gas Company has ordered Cooper gas engine driven compressors totaling over 15,000 H.P., for the largest gas pipe line project in the history of natural gas. The order includes the 500 and 1000 B.H.P. sizes, both of which have become standard for the larger compressor stations built during recent years.

The auxiliary power for water pumps, starting air compressors and lights will be furnished by Cooper Type-80 twin engines direct driving generators.

There will be four large compressor stations on the four hundred and

Empire's Cambridge, Kansas, compressor station contains four Cooper 500 B.H.P. gas engines. No one knows the normal life of these engines because the first one, built in 1909, is still in continuous service.

THE C. & G. COOPER CO

1605 Kirby Bldg., Dallas

649 S. Olive St

ENGINES

standard
45, 85,
500, 760
B.H. P.

Cooper Engines

fifty mile line from the Amarillo field in Texas to Kansas City. Several carloads of engine parts for the first station are already in transit. More than one hundred cars will be required to transport these engines. Shipment will be completed by early fall.

This, the largest order ever placed for gas compressing equipment, is a tribute to Cooper engines, climaxing ninety-four years of engine building experience. It will not, however, especially tax Cooper facilities to complete it on time, and other Cooper customers may expect as prompt service on their compressor requirements as they have had in the past.

Houston Pipe Line Company's Edna, Texas, compressor station, recently put into operation, contains six Cooper 1000 B.H.P. gas engines. A duplicate unit to be added this summer has just been ordered.

COOPER ENGINE COMPANY, Mt. Vernon, Ohio

Los Angeles 604 Kennedy Bldg., Tulsa

pounds to 80 pounds, it was necessary to keep an attendant at the station continuously during the winter months for almost nine years. In 1923 we attempted to determine why this regulator could not be operated without freezing. It was difficult, because of the manner in which it was connected, to install a heater to warm the gas on the inlet side. It would have been a very expensive proposition, because of the large quantity of gas being handled. Our first attempts to apply heat to the regulator body met with very little, if any, success, because the gas carried the heat so applied away from the regulator rather than to it. An examination made immediately after the regulator had refused to function, disclosed the fact that there was scarcely a teaspoonful of water frozen on the valve guides causing them to adhere to the valve seat. We appreciated that if the valve could be guided in such a manner that heat could be applied directly to the guides, the freezing could be prevented by the application of a comparatively small quantity of heat. Our first alteration consisted in removing the valve guides from the bottom valve and replacing them with an inverted cup in the form of a nut on the bottom of the valve stem. This inverted cup was of such a diameter that it had sliding clearance around a pin which was securely anchored in the center of the bottom plate.

We appreciated that by guiding the valve in this manner, a very small amount of heat applied to the bottom plate would prevent the inverted cup freezing to the guide pin. We did not think the top valve would need any alternation because of the peculiar form of the valve. It is ordinarily provided with a straight cylindrical section immediately below the valve face, so that in ordinary operation, no gas is passed through it, during the first part of the upward movement of the valve. It serves only to balance the pressure on the bottom valve. We soon found that we were mistaken and while the regulator worked somewhat better, the changes we had made did not entirely eliminate the freezing. Being somewhat skeptical about our ability to properly guide the valve from the top of the valve body, by means of the stuffing box and lower valve stem, we were slow to remove the guides from the top valve. However, the results were more than we had hoped for. The removal of the valve guides and the cylindrical section immediately below the valve seats, so completely eliminated the possibility of the valve freezing and adhering to the valve seat proper, that the regulator worked with remarkable accuracy, with a very small amount of heat applied directly to the bottom plate. This regulator has been in continuous operation since that time and it has never been necessary to maintain an attendant at the station for a single hour. We were so well satisfied with this type of alteration that we have since altered several hundred regulators in the same manner.

Served Double Purpose

In making these alterations we accomplished the purpose for which we were striving but much to our surprise we accomplished a second equally meritorious purpose. The first purpose was to relieve the tendency toward freezing. We soon discovered that we had also very greatly improved the operation of the regulator making it very much more stable in its operations and entirely eliminating the very peculiar and unexplainable irregularities in the discharge pressure.

I have attempted to illustrate in the accompanying drawing, Figure No. 3, the change which takes place. Assuming that the regulator lever is weighted sufficiently to exactly balance the pressure exerted by the diaphragm, and that the top and bottom valves being of the same size balance each other, everything is in static balance, and for this purpose we will assume that the diaphragm is of such a constant, effective diameter that the balance is not disturbed by the opening of the regulator valve and the resultant upward movement of the diaphragm plate. As soon as gas is admitted through the bottom valve to the outlet piping, a condition of partial vacuum or reduced pressure is created immediately on the bottom of the lower valve which has a tendency to retard the upward movement of the valve. The effect of this increases constantly as the valve is opened and more gas is permitted to flow through the valve. Other things being equal, this increased downward pull has a tendency to assist the action of the diaphragm so that the force exerted by the weighted lever is partially neutralized and counter-balanced, as a consequence of which the pressure is slightly reduced in the discharge line.

Equilibrium Upset

When the valve stem in its upward travel reaches a point where the cylindrical section on the bottom of the top valve passes above the top of the upper valve seat, gas is permitted to pass through the valve for the first time. This change has a tendency to create a condition of reduced pressure above the top valve, counter-balancing to a certain extent and offsetting the similar condition on the bottom of the lower valve. The result is that the condition of equilibrium between the various forces which have been established prior to that time is very materially upset by this new dynamic force. The downward pull of the bottom valve having been counter-balanced releases, at least in part, its downward effort, assisting the diaphragm. The diaphragm alone without that assistance can no longer sustain the weight on the lever. The result is that the lever immediately drops to its downward limit, in which position it remains until the outlet pressure, increases by the sudden additional flow of gas, reaches a point 7 pounds to 15 pounds higher than it was before this unbalanced condition took place. As the lever rises and the increased pressure becomes more effective, the flow of gas is reduced below the normal amount, because of the temporarily increased discharge pressure. As a result of this excessive closing of the valve, the original condition is re-established momentarily, gas flowing through the lower valve only.

Improved Operation

In general the corrections or alterations made, as above described, have very greatly improved the operation of the regulator, by increasing its sensitiveness, no doubt by partial elimination of friction and by the very material reduction of the tendency toward freezing. It has been found possible to operate regulators without heat, which before the alteration, could not be kept operating without considerable heat. The capacity has also been increased appreciably by the elimination of the obstruction to the flow of gas through the valve seats.

A great deal has been written about the variation in the pressure delivered by a regulator. Many of the changes have been attributed to so-called diaphragm effect, but I am wondering if proper consideration has been given to the dynamic forces operating on the valve of the regulator in this manner, and their possible effect on the pressure delivered. It is no doubt true, that the effect of effective diaphragm diameter of a regulator varies with the position of the diaphragm. When the diaphragm is in the lower position, as it is when the regulator valve is closed, an appreciable amount of the pressure exerted on the top of the diaphragm is required to hold the diaphragm alone in this distended position. This reduces the effort applied to the valve stem to counter-balance the weighted lever. In the upper position a considerable upward force is necessary to distend the diaphragm in this direction. This force is substantially equal but opposite in direction to the force required to hold the diaphragm in the lower position. The difference between these two forces when reduced to a pressure per square inch, is a measure of the difference in pressure which the regulator will deliver under these two conditions. This force is also dependent upon the manner in which the diaphragm is placed in the diaphragm case (the amount of surplus material in it) and on the thickness of the material itself. This is especially apparent in regulators arranged to deliver ounce pressure. The difference between the total fluid or gas pressure on the top of the diaphragm and the pressure required to flex the diaphragm material is the force effective to counteract the effort of the weighted lever. This latter being constant means that a varying pressure is required on top of the diaphragm to counter-balance the varying effort required to flex the diaphragm material alone. If the diaphragm material is too tight no amount of pressure will force it into complete contact with the diaphragm plate. In this condition the area of contact with the plate becomes less as the valve moves downward. As the valve is about to close it is necessary that the discharge pressure, effective against the reduced area of contact of the diaphragm with the diaphragm plate, be considerably higher than normal in order to supply the effort necessary to completely close the valve. Very often this accounts for the tendency of a regulator pressure to creep up during periods of substantially no delivery.

This design of regulator as illustrated in Figure No. 4 has been withheld from publication for almost four years until it could be given out, not as a theory, but as an idea proven by years of successful operation.

THE GAS INDUSTRY IN ONE OF AMERICA'S BEAUTY SPOTS

One of the world's largest natural gas compressor stations in West Virginia. A natural gas gasoline plant is shown in distance, in upper left-hand corner of the picture.

Reynolds
Gas Control Since 1892

New Efficiency in operation!

Model -10-

The New Reynolds High Pressure Service Regulator

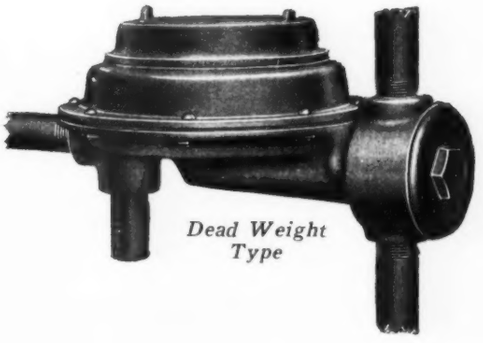
Model—10—is Reynolds' newest achievement—the final embodiment of thirty-five years of world-wide experience in every form of gas control.

A governor which will require less repairs, fewer adjustments, less frequent cleaning, than any pressure governor hitherto devised.

And, greatly increased accessibility of all working points makes whatever adjustments may be necessary quicker, easier, less costly to the gas company, more satisfactory to the consumer.

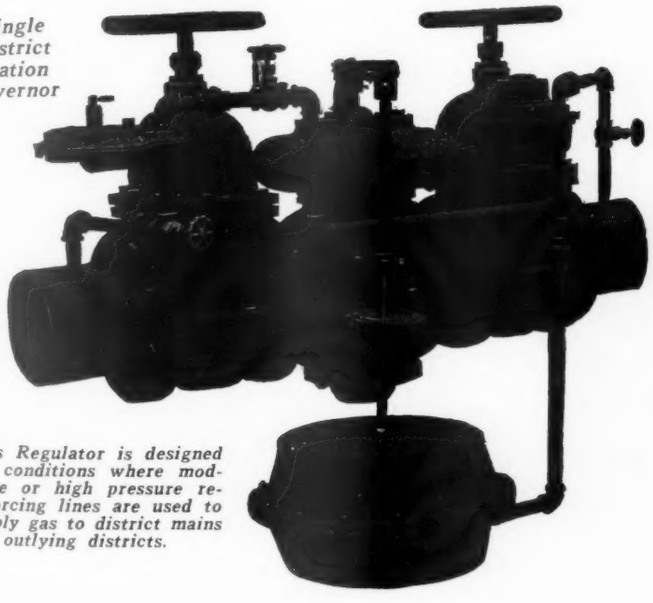
Available for all distribution systems where the customer's service is taken directly from the high pressure line,—up to 100 lbs.

Write for Complete Descriptive Folder

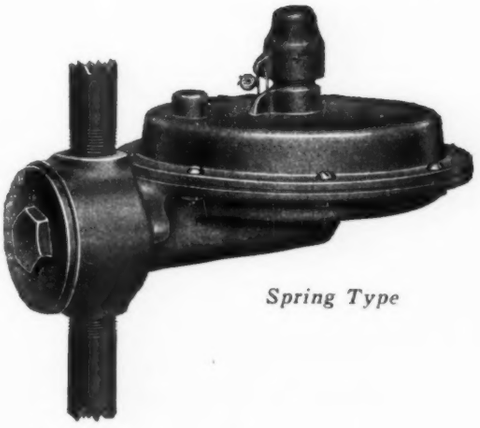


Dead Weight Type

Single District Station Governor



This Regulator is designed for conditions where moderate or high pressure reenforcing lines are used to supply gas to district mains and outlying districts.



Spring Type

Write for Complete Descriptive Folder

Reynolds Gas Regulator Company
Anderson, Indiana

New England Representative: **Eastern Service Co., Boston, Mass.**

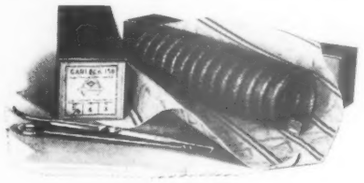
GARLOCK
TRADE MARK

GARLOCK MECHANICAL PACKING SERVICE
FOR THE OIL INDUSTRY

Asbestos, Rubber, Fibrous and Metal Packings

Packing Service There is a Garlock "Quality Controlled Product" for every conceivable oil industry and general equipment condition. These include air, gas, alkali, brine, hot and cold oils, tar, coal gas derivatives, high, medium and low pressure steam, hot and cold water. The Garlock Packing Company maintains a corps of Garlock Service Men in all parts of the country who are packing experts. These men are at your service for consultation on any packing problem.

GENERAL PACKINGS



Garlock 150

Rod Packing Gas Engines, Steam Engines, Centrifugal Hot and Cold Water and Hot and Cold Oil Pumps, Reciprocating Hot Oil Pumps, Slush and Mud Pumps and various oil field and refinery conditions.

Sheet Packing For all service including superheated and saturated steam, air, gas, gasoline, hot or cold water, hot or cold oil and most chemical solutions.

Garlock 952

Gaskets Still Head, Pipe Lines, Manhole and Handhole, Tank Car Dome and Outlet, Gasoline Storage Tanks, Absorption Tower Covers, or wherever a gasket is required.

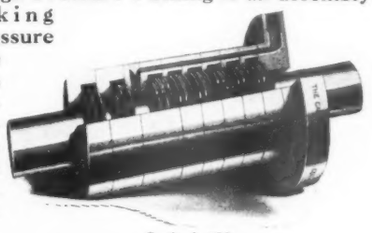
Inserts and Rings Oil Field Rings and various types of inserts and liners for oil field pumps.

Valve Stem Packing Asbestos Valve Stem Packing for ordinary steam, air and oil conditions. For extremely high temperatures see Shredded Metal Valve Stem Packing in next column.

GARLOCK 935

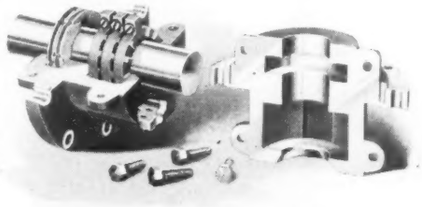
METAL PACKING

Gas and Air Compressor Packing Garlock-875 is designed to work against either high or low pressures. The High Pressure Packing is an assembly of six double-packing rings and two pressure scraper rings, while the Low Pressure is made up of five sections of double packing rings. Complete specifications and blue prints will be supplied upon application.



Garlock 875

Oil Wiper Packing Garlock Oil Return Wall Plate Metal Packing is the first device of its type on the market for this particular condition. It will wipe every drop of oil from the compressor piston rod and return it freely to the crank case. It is so designed that it will take care of the vacuum and low pressure on certain types of power cylinders.



Garlock Oil Wiper Packing

Gas Engine Packing Garlock-860, Gas Engine Packing is a combination of flexible radial cut packing rings enclosed in a case. A special alloyed iron is used in the packing rings which are accurately machined and have greater spring tension to insure satisfactory service.

General Service Metal Packing We also manufacture Flexible Metal Packings for use on piston rods and valve stems of steam engines, pumps, ammonia compressors, as well as oil wiper packings suitable for all types of enclosed crank cases of steam and gas engines.

SHREDDED METAL PACKING

Garlock High Temperature Shredded Metal Packings are manufactured from high heat resisting metal floss bonded under pressure and impregnated with graphite. They will effectively pack against the highest of pressures and withstand heat up to 1500° Fahrenheit.

Garlock-934 is square in cross section and furnished in ring form. Recommended for service on Reciprocating Pistons and Valve Rods. Garlock-935 is furnished in sets in ring form and recommended for High Temperature Valve Stems and Rods and Plungers of Hot Oil Pumps.

For medium temperatures Shredded Metal Packings are furnished in ring or coil form and give excellent service working against gas, air, steam, oil, etc., at temperatures that do not exceed 600° Fahrenheit.

THE GARLOCK PACKING COMPANY

Manufacturers of "Quality Controlled" Mechanical Packings

Palmyra, New York

Oil Field Warehouses and Sales Offices

Houston, Texas Tulsa, Okla. Los Angeles, Calif. Denver, Colo. Pittsburgh, Pa. Cleveland, Ohio

The Standard Packing of the World

Improving Line Pipe is Big Problem

Question Is How Strength Can Be Increased Without Impairing Welding Or Other Essential Qualities of Material

By Frank N. Speller
Metallurgical Engineer, National Tube Co.

With the use of higher pressures in gas lines, the question of improved physical properties and more searching methods for the testing of line pipe becomes more important. For several years lap-welded line pipe has been made of steel within the following range of chemical composition:

TABLE I

	Bessemer Pipe Welded	Open Hearth Pipe Welded
Manganese	0.30—0.60	0.30—0.60
Phosphorus, not over	0.11	0.06
Sulphur, not over	0.065	0.06

The physical properties of the above material will conform to the following minimum requirements:

	Bessemer Welded	Open Hearth Welded
Tensile Strength, Lbs. per Square Inch	50,000	45,000
Yield Point, Lbs. per Square Inch	30,000	25,000
Elongation in 8 inch, per cent	20	22

The question is how can the strength of line pipe be increased without impairing the welding or other essential qualities of this material?

Hot finished seamless pipe is now made in this country up to about 12-inch pipe size, but, considering the higher cost of the seamless pipe, it would obviously only pay to purchase Grade B or C. (See Table II), having a carbon range of about .30 to .45 per cent and a tensile strength of 70,000 pounds per square inch and upwards.

When the pipe is joined by fusion welding, there is some question as to the ability of the average welder to make such joints when the carbon is over 0.25 per cent without occasionally overheating the material at or near the weld. For the best practice in field welding, basic open hearth steel with carbon under .15 per cent is generally preferred. Many weld Bessemer pipe steel satisfactorily and it will be noted that this material is somewhat stronger and stiffer than open hearth steel of the grade used for welded pipe.

Metallurgist Limited

In forge welding, without the use of a flux such as fused borax, carbon over .15 per cent, and silicon, nickel and chromium over .05 per cent interfere with the best welding practice. The welder who cannot depend upon the use of artificial fluxes (as in the manufacture of lap and butt welded pipe) must work within a rather narrow range of temperature, so that he should have the utmost latitude in the choice of favorable welding material.

Evidently then, in the case of welded pipe, the metallurgist is quite limited in the elements that may be added to steel or wrought iron for the purpose of improving the physical properties or corrosion resistant qualities of the metal. In fact it has been claimed with some reason that with the exception of an upper limit on phosphorus, specifications for such steel should only refer to the physical properties and tests desired and thus leave the manufacturer sufficient latitude in which to make steel to conform with the essential requirements.

The elements which may be added to low carbon steel within certain limits without detrimental effects in welding or on other properties of the metal include phosphorus and manganese. Many engineers have been afraid of phosphorus on account of the undesirable brittleness which it gives to medium and higher carbon steels and alloy steels. Phosphorus may be added in the form of a ferro-phosphorus alloy to basic open hearth steel containing not over .15 per cent carbon and initially low in phosphorus (under .02 per cent), up to the same amount as is found in Bessemer steel with general improvement in the welding characteristics of the metal and with considerable increase in strength, apparently without impairing other desirable qualities. In fact rephosphorized basic open hearth steel of the same phosphorus content as Bessemer steel retains all the characteristics of open hearth steel with better physical properties than Bessemer.

Conclusions Cited

The following conclusions are given by Professor F. F. McIntosh as a result of his tests on "The Effect of Phosphorus on the Resistance of Low-Carbon Steel to Repeated Alternating Stresses."[1]

"For the addition of phosphorus (from 0.010 to 0.125 per cent) to Low Carbon Basic Open Hearth steel, containing less than 0.15 per cent C., it may be said from this work and that of others referred to, that (a) it increases the endurance of the material against repeated alternating stresses; (b) it increases the hardness, ultimate strength, and elastic limit; (c) it has no particularly bad effect on the resistance to shock or vibratory strain; and (c) it increases the resistance to corrosion and abrasion and has no well-defined effect on ductility."

The static impact (shock) tests we have made on Bessemer and rephosphorized open hearth steel of the same tensile strength and phosphorous content show on the average:

Bessemer, .090% Phosphorus— 7.5 ft. lbs. energy absorbed.

Rephosphorized O.H .080% Phosphorus —11.4 ft. lbs. energy absorbed.

The manganese content may also be increased up to about 0.80 per cent or perhaps higher without noticeably affecting the welding quality and with a proportional increase in strength. The effect of manganese varies. An increment in strength of about 1,500 to 2,500 pounds per square inch per each 0.10 per cent is obtained, increasing with the amount added; with heat treatment the effect of manganese is still more marked.

Any increase in tensile strength and elastic limit will of course make the pipe harder to bend so that where there is much bending to be done in the field, the softest (and weakest) steel may be desirable.

In the past, dead soft open hearth steel pipe has been used for casing, tubing and other kinds of welded pipe. Evidently a stronger material is now more desirable and even necessary for many purposes, so that it seems the purchaser should have a choice of certain grades within the range that is commercially feasible to make. In the proposed specifications for line pipe three grades are indicated for seamless products, and more than one grade is available for welded pipe.

Unit Tensile Strength

To estimate the unit tensile strength of any steel covered by these specifications add to the minimum figures given in Table II—1,000 pounds for each .01 per cent of carbon over .08 per cent; 900 pounds for each 0.01 per cent phosphorus over .02 per cent; 1,500 to 2,500 pounds for each 0.10 per cent manganese over .30 per cent. For example, ordinary open hearth steel pipe with .08 per cent carbon, .30 per cent manganese, .02 per cent phosphorus and .45 per cent sulphur will have a tensile strength approximating 45,000 pounds per square inch. By increasing the carbon to .10 per cent, the phosphorus to .06 per cent and the manganese to .60 per cent, the tensile strength will be increased to about 56,000 pounds per square inch or by about 11,000 pounds.

[1] Carnegie Institute of Technology Bulletin 25, Page 28 and Mining & Metallurgy, Aug., 1926, Page 332.

The present American Petroleum Institute specification 5-A for oil country tubular material does not specifically cover line pipe. To meet this demand a specification for line pipe has been proposed by a committee of the Natural Gas Association of America, H. C. Cooper, chairman. The present American Petroleum Institute specification 5-A has the following chemical and physical requirements:

TABLE II

Chemical Properties—The steel shall conform to the following requirements as to chemical composition:

	Bessemer Welded	Open Hearth Welded	Open Hearth or Electric Seamless A Grade	B Grade	C Grade
Manganese	.30—.60	.30—.60	.30—.60	.35—1.50	.35—1.50
Phosphorus, not over	.11	.045	.04	.04	.04
Sulphur, not over	.065	.06	.06	.06	.06

Physical Properties—

	Bessemer Welded	O. H. Welded	Seamless Grade A	Grade B	Grade C
Tensile strength, lbs. per sq. in.	50,000	45,000	48,000	70,000	75,000
Yield point, lbs. per sq. in.	30,000	25,000	30,000	40,000	45,000
Elongation in 8", per cent	20	22			
Elongation in 2", per cent			40	25	20

Wrought Iron

Tensile strength, lbs. per sq. in.	42,000
Yield point, lbs. per sq. in.	24,000
Elongation in 8", per cent	12

Open Hearth Iron

Tensile strength, lbs. per sq. in.	45,000
Yield point, lbs. per sq. in.	25,000
Elongation in 8", per cent	22

Revision Suggested

In order to include line pipe and other tubular material commonly used in the oil industry, and also to give the purchaser the widest range of choice of material, and further recognizing the fact that requirements vary widely with the kind of service, it might be well to revise Section 3-a of Specification 5-A on chemical composition in the present American Petroleum Institute specification (Table II above) so that it will cover all classes of oil country tubular products as suggested in Table III.

TABLE III

Proposed Chemical Requirements for All Classes of Oil Country Tubular Goods.

	Bessemer Welded	O. H. Welded	Seamless Grade A	Grade B	Grade C
Manganese	.30—.60	.30—.60	.30—.60	.35—1.50	.35—1.50
Phosphorus, not over	.11 (*Class A .08) (*Class B .04)		.04	.04	.04
Sulphur, not over	.065	.06	.06	.06	.06

*Class A, open hearth welded steel, is adapted for casing, tubing and for other purposes where extra strength and stiffness are desirable.

*Class B is not rephosphorized and may be ordered where extreme softness and ease of bending are the main requirements.

The tensile strength of Class A is over 50,000 lb./in. and the elastic limit is over 30,000 lb./in. with the same elongation as specified for Class B.

It will be noted that the chemical composition specified in the A. P. I. specifications refer to chemical tests made on the skelp or finished pipe. To meet these requirements the manufacturer must work to a ladle test about 20 per cent lower than the maximum limit: that is to say, .060 per cent maximum sulphur requires a ladle test not over .048 or .050 per cent.

Effect on Corrosion

The influence of variations in composition of steel within the limits given in above specifications appears to be almost negligible on corrosion underground. In many locations, the four-year inspection of soil corrosion tests just completed and reported by the United States Bureau of Standards again points to this conclusion, although in some of the 47 localities where these tests are being conducted the corrosion has not progressed far enough to warrant any conclusions being drawn as yet.[2]

To secure longer life of the metal underground, impervious protective coatings should be applied, the soil may be drained or treated (although this is rarely practicable), or a special composition of steel may be used. The latter at present includes mainly the high-chromium (stainless) group of ferrous alloys with various amounts of nickle, silicon or copper. All of these excellent ferrous alloys are too costly to be considered for line pipe at present but they are finding a wider application every day for important parts of equipment where first cost is a lesser consideration.

Considering Corrosion

Two important conferences on corrosion in the oil industry have been held during the past six months.[3] At the American Petroleum Institute conference in Tulsa last December it was recommended that a committee be appointed to study the problem, to outline a policy to conserve this waste, and to recommend a definite organization and procedure to carry this into effect. A letter and questionnaire on corrosion have been sent out by the preliminary committee recently appointed by President E. W. Clark of the Petroleum Institute:

The gas industry is particularly interested in finding a practical solution of the soil corrosion problem. They are almost as much interested in this aspect of corrosion as are their friends and associates in the oil industry. Some plan of co-operation may be developed whereby these large interests and others may be able to co-operate in working out a practical solution of this important problem.

The American Petroleum Institute corrosion committee will be glad to receive data called for in their letter of inquiry from any of those interested in the gas industry.

A more fundamental study of soil corrosion and of the factors involved is evidently necessary. The Bureau of Standards has done much important and useful work in this direction but it recognizes that it is only a start and should be greatly extended before practical results may be expected.

[2] Paper by Logan, K. H., Meeting of Am. Inst. Min. and Met. Eng., N. Y., Feb. '27.

[3] American Petroleum Institute, Tulsa, Okla., Dec. 1926; American Institute of Mining and Metallurgical Institute, New York, February, 1927.

OIL REFINERY CONSUMES 70,000,000 FEET DAILY

The Baton Rouge refinery of the Standard Oil Co. of Louisiana is said to be the largest individual industrial consumer of natural gas in the world. Natural gas is used under the stills at this refinery and the plant operates 834 fires with Coen combination burners. It is said the refinery consumes 70,000,000 cubic feet of natural gas daily, this gas being transported to the plant from the Monroe Field in Louisiana through the 170-mile pipe line. Combination burners are used so that oil may be used at any future time it might be decided desirable.

Factors Determining Building of Line

The Available Gas Supply; Suitable Market and the Extensiveness of Transmission System Big Considerations

By R. W. Gallagher
President, The East Ohio Gas Co.

The discovery of large natural gas pools in the South and Southwest during the last few years, located as they are at great distances from suitable markets, has presented to the natural gas industry, and those interested in natural gas investments, the necessity for determining with accuracy the feasibility of long high pressure transmission lines.

Investors must be assured that the large amounts of money required for projects of this kind are amply secured, that sufficient reserves can be set aside for return of invested capital and the earning possibilities during the period when these reserves are being set aside and for a certain period thereafter, will be sufficient to justify investments in such projects.

These questions are more easily asked than answered and, yet, if natural gas projects of this kind are to maintain their present desirable position with the investing public, they must be correctly answered. For this reason, it is important that those having any such projects in mind make a most thorough and searching investigation of all the essential factors entering into a large undertaking of this character.

Essential Factors

What are these factors? They are, in brief:

The available gas supply.

A suitable market.

The extensiveness of transmission system.

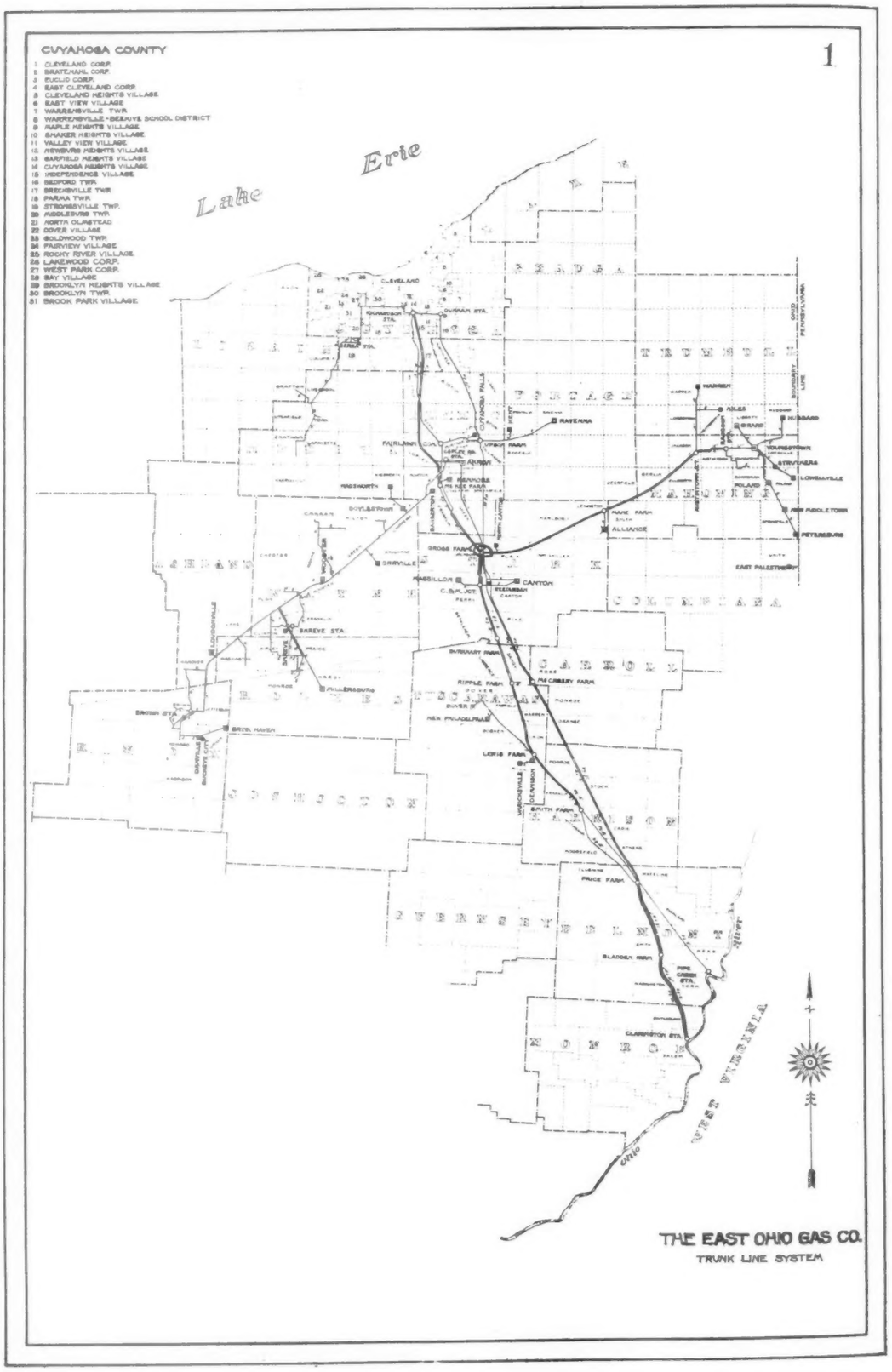
For the purpose of this article, we will discuss these factors in the order named, keeping in mind the correlation that each must have to the other two, in order that the project may be successful.

Naturally, the first factor is the gas supply for the reason that the discovery of a large gas field is fundamentally necessary. Our first question is, therefore, is the territory that has been opened of sufficient size or, in the language of the gas men, does it contain sufficient gas reserves to warrant the consideration of marketing possibilities.

On this point it is only reasonable that the investor should base his conclusions on the conditions of the territory at the time of the investigation, demanding that any future extensions of the then defined fields should be held as an offsetting factor against the possibility of more rapid depletion that might be reasonably expected under average conditions. It is important that there be sufficient gas in sight to amortize the investments necessary for marketing same. For this reason the quantity of recoverable gas is, of course, the dominating factor. Geologists and practical field operators, by giving consideration to the drilled portion of the territory, can determine to a fair degree of accuracy this portion of the problem. Naturally, at the time of the investigation, there should be a number of producing gas wells covering a large acreage as, otherwise, the matter would not be up for consideration.

Wells Basis of Data

It is from these wells that the basic information of the probable gas reserves is obtained. The amount of gas recovered per acre per pound drop in rock pressure is a factor that should be given careful consideration. The thickness and porosity of gas bearing sand and the rock pressure of the gas are other items of importance. All of these should be given most careful thought by the geologist. The practical gas man knows, through long experience, that many factors not readily foreseen in a survey of this kind tend to greatly decrease the life of gas fields, such as water conditions, the possibility of competitors draining the territory and



other matters which experience has taught him, have a direct and important bearing on the productivity and life of the field.

It is obvious that sufficient acreage must be controlled not only to assure an adequate supply of gas, but also to make it possible to produce the gas with a minimum investment in wells.

This does not necessarily mean that the companies back of the project must own outright all the territory held in reserve. Gas purchase contracts with other producers may also be desirable. It must be kept in mind that, whether the gas leases are owned outright by the company interested in the project or reserved under gas purchase agreements, the paramount consideration must be that the gas will be held in reserve and the project assured of a sufficient supply over such a period as will bring financial success to the undertaking.

The cost of gas, whether produced or purchased, must be carefully analyzed so that the maximum fixed costs may be ascertained over the period for which the development is projected. This point is equally essential with that of determining the gas reserve. It may be readily seen that while there may be sufficient gas reserve to support the project, the cost of delivering gas to the pipe line over a period of years may be such as to make the undertaking an unprofitable one. An adequate supply of gas having been satisfactorily ascertained, the next thing to be considered is the possible market for the gas.

Domestic Sales Vital Factor

Ordinarily, there is one outstanding city which determines the terminal of the transmission line and this city, in conjunction with other towns and cities that could be supplied by the transmission line, will determine the potential sales.

If domestic sales are to be the controlling factor, and usually they are, the practicability of the line will depend largely upon the sales of gas for house heating and, naturally, the retail price of gas must be such as will attract this class of business. Questions such as climatic conditions, the price of the fuels in use for house heating purposes, as well as the money income of the consuming public, all have a direct bearing upon the rates which can be established. These matters must be carefully weighed and have the most careful consideration.

The rate structure is most important. The rate must be one that will obtain the greatest portion of house heating and commercial business, but without overlooking the superiority of gas over other fuels in maintaining constant temperatures, its cleanliness, its ease of control and its many other advantages.

It is also important that the rate schedule include a service charge and, possibly, a demand charge so that the house-heating and larger consumers are not burdened with the cost of carrying the great number of small, unprofitable consumers as is the case when gas is sold at a flat rate.

The industrial possibilities must also have most careful consideration. They can be determined only by making a complete survey covering the quantities and prices of fuels used by all industrial concerns within reach of the distribution system. This survey will, naturally, eliminate some of the industrial concerns as possible gas users, but at the same time it will disclose those industries which can, when consideration is given to all the advantages obtained by the use of gas, better afford to substitute it for the fuels then in use.

As the pipe line and distribution systems are primarily constructed for the domestic market, this industrial business can many times be taken on at a very small margin of profit, especially if it can be obtained when the transmission line capacity is not needed for domestic and commercial business.

Cost of Line and Stations

We now take up the transmission of gas from the field to the market. The cost of the pipe line and compressing stations usually determines the feasibility of the project. In deciding upon the selection of the route, the length and cost of the line over the shortest possible route must be balanced against any possible markets for gas along other routes which may be much longer and more expensive. The topography of the country to be traversed usually indicates two or three possible routes with the markets enroute the determining factor. The size of the line is largely dependent on the maximum hourly delivery as determined from a survey of the market possibilities, plus a consideration for possible business that may develop, in addition to what has been contemplated. The question of compressing equipment necessary and of the line pressures to be carried present a problem for each individual case. These are purely engineering problems and can be readily determined.

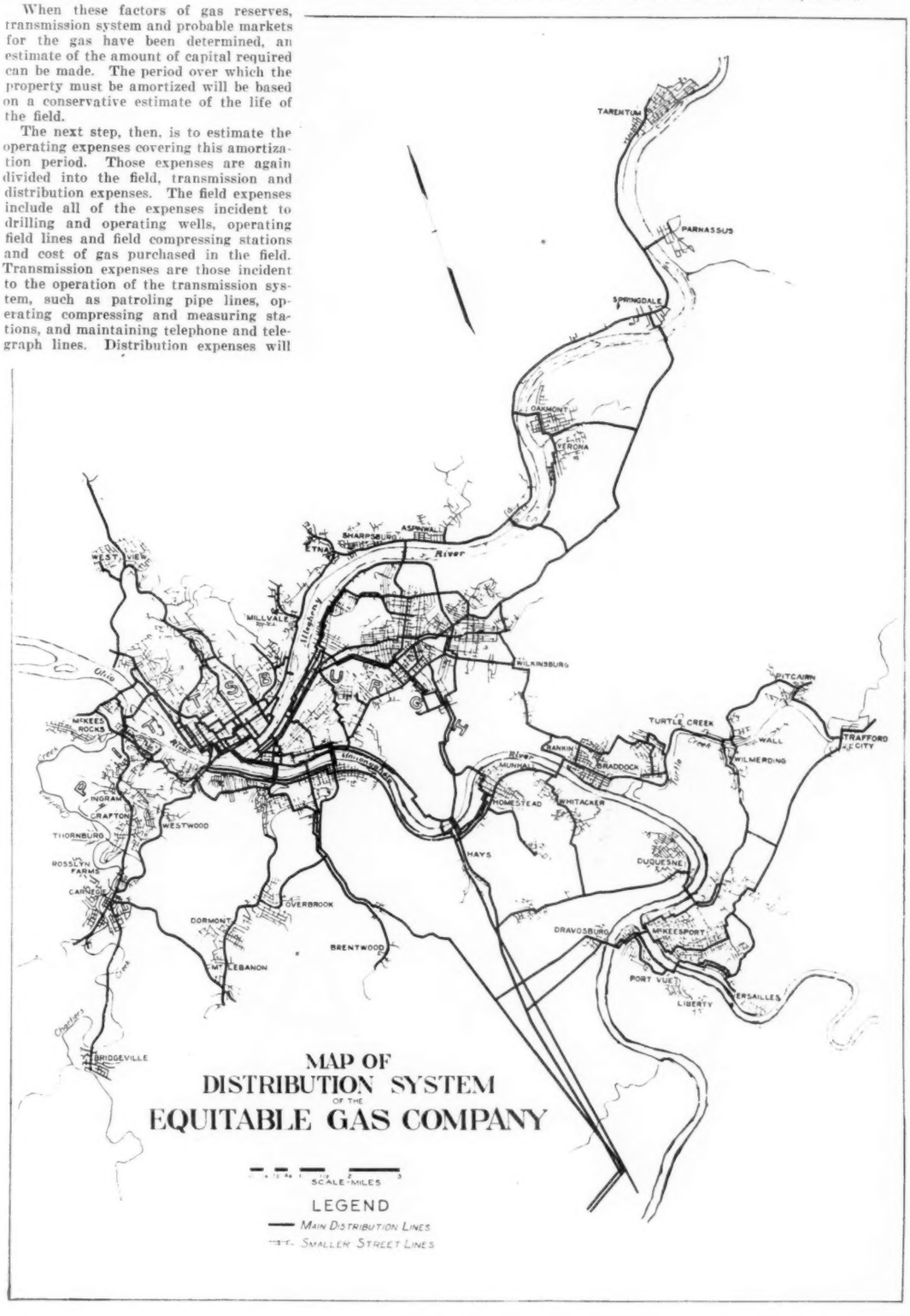
When these factors of gas reserves, transmission system and probable markets for the gas have been determined, an estimate of the amount of capital required can be made. The period over which the property must be amortized will be based on a conservative estimate of the life of the field.

The next step, then, is to estimate the operating expenses covering this amortization period. Those expenses are again divided into the field, transmission and distribution expenses. The field expenses include all of the expenses incident to drilling and operating wells, operating field lines and field compressing stations and cost of gas purchased in the field. Transmission expenses are those incident to the operation of the transmission system, such as patroling pipe lines, operating compressing and measuring stations, and maintaining telephone and telegraph lines. Distribution expenses will include repairing, changing, and lowering street lines, repairing services and meters, inspections and numerous other expenses. To all the above field, transmission and distribution expenses, there must be added allowances for fixed charges such as taxes, interest, amortization, depreciation, and return on investment.

Consider Area Near Market

Consideration must also be given in cases where the gas is carried from distant fields, to the possibility of gas being produced in paying quantities at points nearer to the markets to be served. With this in mind, it is well to have a survey made of the territory surrounding proposed markets, which survey should give consideration to all wells which may have been drilled in the territory, to the possibility of known sands developing gas in commercial quantities and to other data having reference to this important phase of the subject.

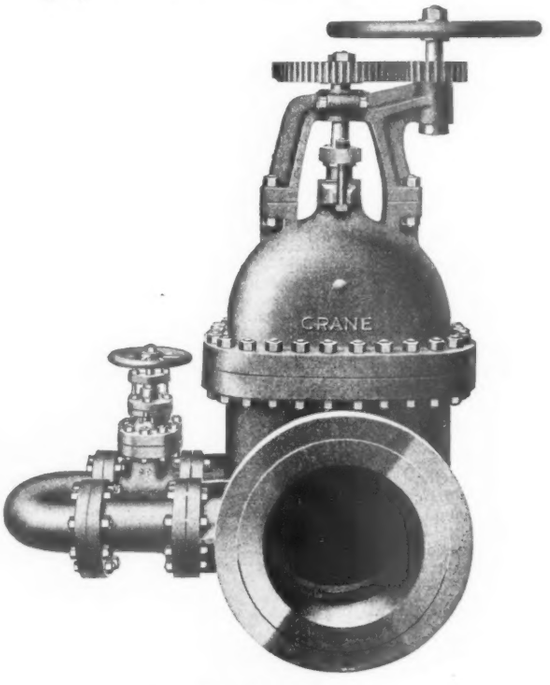
With the foregoing facts determined, it can then be determined whether or not the estimated earnings will be sufficient to satisfy the investor in natural gas securities. It is most desirable, for the benefit of the industry at large, that all estimates be most conservative and that every possible safeguard be used to maintain the integrity of the natural gas investment. This is just as essential to those recommending new projects as to present owners. If the new project is successful, as it will be if based upon careful and conservative lines, it will operate to the benefit of its owners and the integrity of the gas industry as a whole will be further emphasized.



Offering dependable piping materials

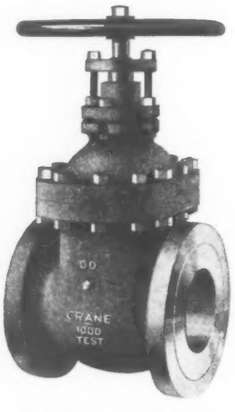
Double disc gate valves of ferrosteel and iron

Gate Valve No. 345-E



Gate Valve No. 346-E

Gate Valve No. 340-E



Gate Valve No. 341-E

Gate Valve No. 343-E

CRANE

Address all inquiries to Crane Co., Chicago

GENERAL OFFICES: CRANE BUILDING, 836 S. MICHIGAN AVENUE, CHICAGO

Branches and Sales Offices in One Hundred and Sixty-two Cities

National Exhibit Rooms: Chicago, New York, Atlantic City, San Francisco, and Montreal

Works: Chicago, Bridgeport, Birmingham, Chattanooga, Trenton, Montreal, and St. Johns, Que.

CRANE EXPORT CORPORATION: NEW YORK, SAN FRANCISCO, MEXICO CITY, HAVANA
CRANE LIMITED: CRANE BUILDING, 1170 BEAVER HALL SQUARE, MONTREAL
CRANE-BENNETT, LTD., LONDON
CIE CRANE: PARIS, BRUSSELS

For field, pipe line, refinery, home

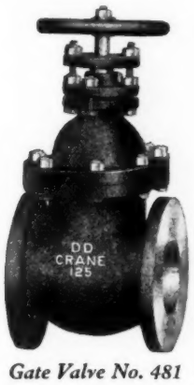
Double disc gate valves, globe valves, and clamp gate valves

Gate Valve No. 754

Gate Valve No. 755

Gate Valve No. 757

Gate Valve No. 480



Gate Valve No. 481

Gate Valve No. 483

Globe Valve
No. 7, Brass

Globe Valve
No. 212, Brass

Globe Valve
No. 354½, Iron

Clamp Gate Valve
No. 488, Iron

CRANE

Address all inquiries to Crane Co., Chicago

GENERAL OFFICES: CRANE BUILDING, 836 S. MICHIGAN AVENUE, CHICAGO

Branches and Sales Offices in One Hundred and Sixty-two Cities

National Exhibit Rooms: Chicago, New York, Atlantic City, San Francisco, and Montreal

Works: Chicago, Bridgeport, Birmingham, Chattanooga, Trenton, Montreal, and St. Johns, Que.

CRANE EXPORT CORPORATION: NEW YORK, SAN FRANCISCO, MEXICO CITY, HAVANA
CRANE LIMITED: CRANE BUILDING, 1170 BEAVER HALL SQUARE, MONTREAL
CRANE-BENNETT, LTD., LONDON
CIE CRANE: PARIS, BRUSSELS

Designed after long, careful study

A complete line of malleable iron fittings

Elbow No. 260-E

Elbow No. 262-E

Tee No. 264-E

Cross No. 266-E

Street Elbow No. 268-E

Elbow No. 760

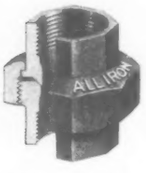
Elbow No. 762

Tee No. 764

Cross No. 766

Street Elbow No. 768

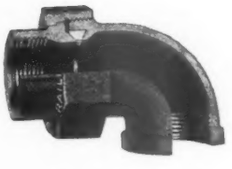
Navy Union
No. 98-E



All-iron Union
No. 98½-E

Railroad Union
No. 519

Railroad Union
No. 519½



Railroad Union
No. 590

Railroad Elbow
No. 591

Railroad Elbow
No. 592

Railroad Elbow
No. 593

Railroad Tee
No. 594

Railroad Tee
No. 596

45° Elbow

60° Elbow

Street Elbow

Side Outlet Elbow

Drop Elbow

Long Drop Elbow

CRANE

Address all inquiries to Crane Co., Chicago

GENERAL OFFICES: CRANE BUILDING, 836 S. MICHIGAN AVENUE, CHICAGO

Branches and Sales Offices in One Hundred and Sixty-two Cities

National Exhibit Rooms: Chicago, New York, Atlantic City, San Francisco, and Montreal

Works: Chicago, Bridgeport, Birmingham, Chattanooga, Trenton, Montreal, and St. Johns, Que.

CRANE EXPORT CORPORATION: NEW YORK, SAN FRANCISCO, MEXICO CITY, HAVANA
CRANE LIMITED: CRANE BUILDING, 1170 BEAVER HALL SQUARE, MONTREAL
CRANE-BENNETT, LTD., LONDON
CIE CRANE: PARIS, BRUSSELS

With advice of oil and gas engineers

Brass cocks, motor and hydraulic operated valves, and other materials

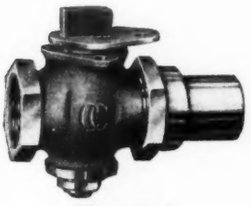
Gas Service Cock No. 270

Gas Service Cock No. 272

Gas Service Cock No. 284

Gas Service Cock No. 285

Meter Cock No. 280

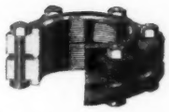


Meter Cock No. 288

Heavy Gas Service Cock No. 292

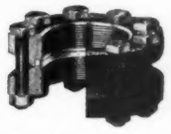
Heavy Gas Service Cock No. 294

Iron Globe Valve No. 1504

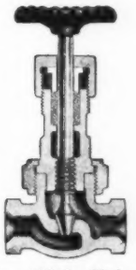


Malleable Iron Flange Union No. 773

Malleable Iron Flange Union No. 99½-E

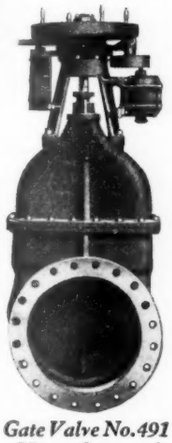


Malleable Iron Hydraulic Union No. 245-H

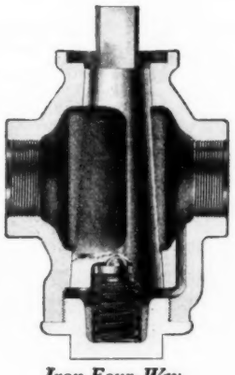


Iron Globe Valve No. 1504½

Ferrosteel Return Bend No. 1559

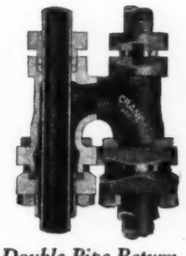


Gate Valve No. 491 Motor Operated



Iron Four-Way Cock No. 339

Gate Valve No. 491 Hydraulic Operated



Double Pipe Return Bend No. 1575

CRANE

Address all inquiries to Crane Co., Chicago

GENERAL OFFICES: CRANE BUILDING, 836 S. MICHIGAN AVENUE, CHICAGO

Branches and Sales Offices in One Hundred and Sixty-two Cities

National Exhibit Rooms: Chicago, New York, Atlantic City, San Francisco, and Montreal

Works: Chicago, Bridgeport, Birmingham, Chattanooga, Trenton, Montreal, and St. Johns, Que.

CRANE EXPORT CORPORATION: NEW YORK, SAN FRANCISCO, MEXICO CITY, HAVANA
CRANE LIMITED: CRANE BUILDING, 1170 BEAVER HALL SQUARE, MONTREAL
CRANE-BENNETT, LTD., LONDON
CIE CRANE: PARIS, BRUSSELS

Salient Features of Gas Distribution

Many and Varied Problems Encountered by Companies in Installing and Operating a System in Cities and Towns

By T. H. Kerr
Engineer, the Ohio Fuel Gas Co., Columbus, Ohio

When considering the advisability of piping a town or village for natural gas it is necessary to make a very careful check of the problem. Even experienced gas men make mistakes when estimating the earnings from newly piped towns. In estimating the number of consumers to be expected ultimately it is customary to assume one for each five people in the town. However, this proposition is only attained after several years' operation.

The gas sold per consumer varies considerably in different localities and with the rate charged. In communities served with manufactured gas the average sales per consumer per year varies from 30,000 to 50,000 feet per year, while in communities served with cheaper natural gas the average consumption is as high as 200,000 feet per year per consumer. The average consumtion of natural gas is from 60,000 to 100,000 feet per year per consumer.

In estimating the sales in a new community it is advisable to make a careful canvass of the residents and get as many contracts as possible in advance. It is necessary then to estimate the quantity of gas which the average consumer will burn at the rate which must be charged and the total gas which can be disposed of and the money represented. Having this information it is a simple problem of economics to decide, the advisability of proceeding farther.

The Piping System

1. In computing the size piping required for transmitting the gas in a distribution system from one point to another, it is necessary to estimate the quantity of gas to be transported based on the number of consumers which might reasonably be expected, and assuming that each consumer burns the quantity of gas which is represented by the average as predetermined in the original estimate of the amount per year, per consumer. The quantity for a shorter unit of time or the peak load (maximum hour) can be determined by the use of the factor representing the ratio of the average delivery to the maximum hour, as determined by actual measurement in a similar community. In addition to this estimated amount, an allowance must be made for unexpected and unforeseen expansion. There are several well-known pipe line flow formulas which may be used for this purpose but care must be exercised in their use to see that the units of pressure and length of pipe are used properly. Some of the formulas are intended for low pressure distribution work and the units of length are expressed in feet, and the pressure in ounces or inches of water, whereas, others are intended for use on main high pressure transmission lines and the units are expressed in miles and pounds, respectively.

It may be of interest to the reader to know that in southern and midwestern states and in some instances in the eastern states where gas is relatively cheaper, that the ratio of maximum hour to average delivery is much greater than it is in the areas of more uniform temperature, where natural gas costs more relatively. You will find herewith a table of ratios of the deliveries for various units of time, as shown by an analysis of the delivery of gas into the cities of Columbus and Springfield, Ohio:

Table of Ratios of Gas Consumption for the Year Beginning Noon January 1, 1925, and Ending Noon, January 1, 1926

	*Columbus	Springfield
Total yearly consumption	7,639,176M	1,489,150M
Maximum month—	Jan., 1925	Dec., 1925
amount total	983,124	190,499
Minimum month—	July, 1925	June, 1925
amount total	343,008	63,809
Average month—		
amount total	663,066	127,154
Maximum day—	Dec. 27	Dec. 27
amount total	45,424	9,584
Minimum day—	Sept. 22	Sept. 6
amount total	10,723	1,559
Average day—		
amount total	28,074	5,572
	Dec. 28	Dec. 27
Maximum hour—	10 to 11 am	8 to 9 am
amount total	2,156	494
	Sept. 23	Sept. 7
Minimum hour—	3 to 4 am	2 to 3 am
amount total	404	39
Average hour—		
amount total	1,280	267
Average hour to total year	.00017	.00018
Ratio of maximum month to total year	.12870	.12792
Ratio of minimum month to total year	.04490	.04285
Ratio of minimum to maximum month	.34890	.33496
Ratio of maximum day to total year	.00595	.00644
Ratio of maximum day to maximum month	.04620	.05031
Ratio of maximum day to minimum month	.13243	.15020
Ratio of maximum day to average month	.06851	.07537
Ratio of maximum day to minimum day	4.23613	6.14753
Ratio of maximum day to average day	1.61801	1.72003
Ratio of minimum day to total year	.00140	.00105
Ratio of Minimum day to maximum month	.01091	.00818
Ratio of minimum day to minimum month	.03126	.02443
Ratio of minimum day to average month	.01617	.01226
Ratio of minimum day to maximum day	.23606	.16267
Ratio of minimum day to average day	.38195	.27979
Ratio of maximum hour to total year	.00028	.00033
Ratio of maximum hour to maximum month	.00219	.00259
Ratio of maximum hour to minimum month	.00629	.00774
Ratio of maximum hour to average month	.00325	.00389
Ratio of maximum hour to maximum day	.04746	.05154
Ratio of maximum hour to minimum day	.20106	.31687
Ratio of maximum hour to average day	.07680	.08866
Ratio of maximum hour to minimum hour	5.33663	12.66667
Ratio of maximum hour to average hour	1.68438	1.85019
Ratio of minimum hour to total year	.00005	.00003
Ratio of minimum hour to maximum month	.00041	.00020
Ratio of minimum hour to minimum month	.00118	.00061
Ratio of minimum hour to average month	.00061	.00031
Ratio of minimum hour to maximum day	.00389	.00407
Ratio of minimum hour to minimum day	.03768	.02502
Ratio of minimum hour to average day	.01439	.00700
Ratio of minimum hour to maximum hour	.18738	.07895
Ratio of minimum hour to average hour	.31563	.14607

*Does not include Arlington.

Getting Gas to the Homes

Number of consumers to be served, quantity of gas to be transported and probable consumption per consumer should be approximated in determining whether system should be constructed and size of pipe to be used.

Ratio of maximum hour to average delivery is much greater in southern and midwestern states than it is in areas of more even temperature.

Mains should be laid in alleys, if possible, and if city is not laid out with alleys, it is highly desirable to place two lines, one on each side of the street, either immediately inside or outside the curb.

Lines should not be laid on streets occupied by electric street cars, on account of electrolysis.

Frequent tests should be made of new lines being laid, a portable air compressor being best equipment for this purpose.

Where there is possibility of substituting manufactured gas, within a reasonable time, it is advisable to lay all mains and services of any size to a definite grade so that drips may be installed when necessary without additional expense of grading.

Equipment used is an important factor and selection of proper meters, etc., should be watched carefully.

Satisfactory set of rules and regulations for service by company to consumer and giving obligations of consumers is cited.

Location of Mains

2. Having determined the size of the main needed to transport the gas through the various parts of a distributing system, the next question to be decided is their exact location. If the community to be served is so laid out that there are alleys between the streets, the cheapest arrangement of piping is to place the lines in the alleys in as far as possible. This necessitates extending the service lines through the lots to the rear of the residences. If the alleys are paved, the paving is usually thinner and easier cut in case it is necessary to uncover the lines for repairs. If, however, the community does not embrace a system of alleys and the streets are paved, it is highly desirable where possible to place two lines, one on either side of the street, either immediately inside or outside of the curb.

The selection of the pipe to be used for this purpose is entirely optional with the company. Some large companies prefer to use cast iron pipe, because of its long life. The most satisfactory joint for pipe of this kind has for a number of years been a subject of considerable debate. Arguments pro and con have been freely voiced in all conventions of gas men. Within the past few years, however, some very successful attempts have been made to braze cast iron pipe. We are led to believe that, while somewhat expensive, the process is very satisfactory. Steel pipe either lap or butt welded is quite generally used, and it may be coupled with screw couplings or by the use of Dresser type plain or insulated couplings.

Corrosion and Electrolysis

The consensus of opinion of the gas fraternity seems to be that the use of some form of protective pipe coating care should be exercised to see that the pipe is not exposed to cinder or slag deposits or to water carrying sulphur or other deleterious substance. Ordinary clay is a fairly good protection from the injurious effects of cinder or other corrosive agents. Where lines are to be laid in the immediate vicinity of electric power or substations, it is advisable to make liberal use of insulating couplings. It is commonly recommended that no gas lines be laid on streets occupied by interurban or street car tracks. Where it is necessary to serve consumers on such a street the lines should be kept as far in the rear of the premises as possible. If no suitable alleys are available the lines should run across lots, each joint being thoroughly insulated. This type of construction has been found very effective as an electrolysis preventive.

Where, in the opinion of the management of a distributing company, there is a possibility of substituting manufactured gas, within a reasonable time, it is advisable to lay all mains and services of any size to a definite grade, so that drips may be installed when necessary without the additional expense of grading the lines. Where this is done it is necessary that a very careful map record be kept on the location and elevation of the lines throughout the entire plant. Even though it may not be deemed necessary to exercise this precaution, the careful mapping of the piping system to show the exact location of all lines is of vital importance and should receive the most careful attention. The maps should, where possible, show the exact location with respect to curbs and other reference points, the location of all interconnections or special fittings of any kind and the location of all taps where possible.

Testing New Lines

Frequent tests should be made of new lines being laid, so that any leaks or imperfect lengths of pipe may be properly disposed of before the lines are completely covered. The most satisfactory method is to use a portable air compressor and to test each 500 or 600 feet of pipe separately by introducing sufficient compressed air to increase the pressure in the low pressure lines to approximately 10 pounds and correspondingly higher in the higher pressure lines. A section so tested should show no pressure drop for a period of several hours before it is connected to the previously completed sections. In making tests of this kind it is essential that some attention be paid to the temperature. The writer has in mind the piping system of a low pressure plant, in a community of 200 consumers, which was closed in on a warm afternoon and which was found to have a pressure of considerably less in atmosphere (or a partial vacuum) when opened for testing early the following morning. This small town plant did show an apparent loss, while an accurate test the same day showed that it was absolutely free from leakage. Unless a line is tested before it is entirely covered, it is almost impossible to locate any but

"TOLEDO"

TRADE-MARK REGISTERED

When real service and satisfaction is desired experienced operators who realize the importance of having dependable pipe tools are sure to specify genuine "TOLEDO" trademark tools.

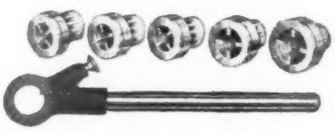
They know from years of experience that for ease of operation, smooth, perfectly tapered standard threads, and year in and year out dependable service, there are no tools that can equal genuine "TOLEDO"s.

"TOLEDO"s are simple in construction, strongly built, have few moving parts, and therefore assure maximum service under severe operating conditions, such as exist in the oil and gas fields. Although covered with dirt and grease, and exposed to the weather, they will continue to do their work year after year with but minor repairs.

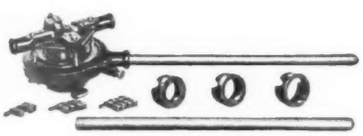
The "TOLEDO" line comprises cutters and threaders for all sizes up to 12″ inclusive—portable and compact, one-man-operated tools that will cut or thread the pipe in any place or position.

When making out your next requisition for pipe tools be sure you specify genuine trademark "TOLEDO"s and you are assured satisfaction.

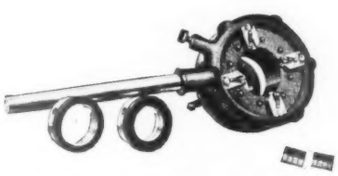
A Few Representative Tools of the Complete "TOLEDO" Line



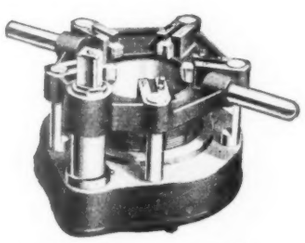
"Toledo" No. 00—Compact, easy to operate, little ratchet threader for ⅛″ to ¾″.



"Toledo" No. 1-A—The 1″ to 2″ ratchet threader, known everywhere for its efficiency.



"Toledo" No. 1½-R—Made for cutting special 11½ pitch on 2″, 2½″ and 3″ oil well tubing.



"Toledo" No. 2-A—2½″ to 4″ geared pipe threader that threads easily anywhere.

THE TOLEDO PIPE THREADING MACHINE CO. TOLEDO, OHIO

NEW YORK OFFICE, 72 LAFAYETTE ST.

This "TOLEDO" Catalogue is a Veritable Handbook on Pipe Cutting and Threading. Ask Us for Your Copy.

the largest leaks in a new plant, because there are no surface indications in the newly filled ditch such as are readily apparent in the covering over an old line.

The reduction of leakage in the older portions of a distributing system demands constant attention on the part of not only the gas plant manager but of each employe, however humble his position. The gas company employes must be constantly on the alert and continually watching for evidence of leakage, if the lost or unaccounted for gas is to be kept within reasonable boounds.

Maintaining Pressure

3. In view of the fact that the service which a consumer may enjoy is dependant on the uniformity of the pressure, at his appliance, it is essential that the line connecting the appliance to the street be of such size that there will be no appreciable loss in pressure between the gas main and the point of utilization.

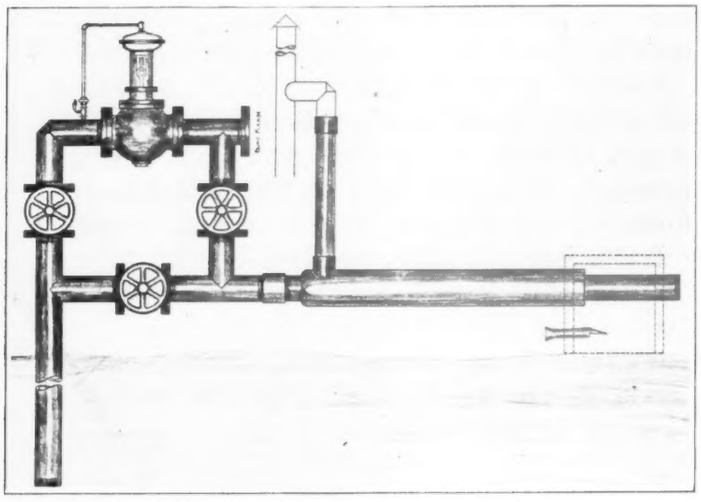


Figure 1

To this end it is common practice for gas companies to require that their consumers install service lines of not less than certain predetermined sizes, dependent on the customer's expected requirements. The smallest service line which is permitted, generally for ordinary single house installations is 1¼-inch. The usual practice is for the company to install service lines from the main line to the consumer's property or to the curb, the consumer being required to extend the line from that point to the location of the meter and to use pipe of a size specified by the rules of the local company, if service is to be established.

After making suitable provisions for the connection of the meter the lines beyond that point are commonly referred to as house lines. In this connection there are also quite definite requirements as to the pipe size. The usual requirements are that at least 1¼-inch pipe be extended to all heating furnaces and in addition not less than 1¼-inch pipe must be used from the meter to the first branch. Risers extending to a second or third floor are required to be at least three-quarter-inch. All valves in the house piping are required to be located so that the packing boxes can be adjusted or repacked without disturbing any of the connections. The usual regulations require that both the house piping and service lines to be tested and proven absolutely tight at a pressure of approximately 10 pounds before a main will be connected or service established. A test of this kind is either made or witnessed by a competent representative of the gas company.

The following is a fine example of gas company rules and regulations governing service to its consumers:

Rules and Regulations of Service

1. All applications, whether for the installation of service line, setting of meter and/ or for a supply of gas, must be made at the local office of the gas company, on the printed forms to be prescribed by the gas company from time to time, and must be signed by the persons making such application.

2. The company cannot and does not guarantee either a sufficient supply of gas, or an adequate pressure of gas, and will not be liable for damage or loss resulting from any variations in pressure, from shortage of gas, or from the total interruption of the gas supply. Where gas for industrial purposes is supplied directly from what are termed high or intermediate pressure mains, such a consumer shall install lines from the meter of the company to the consumer's appliances of sufficient size to secure the necessary volume of natural gas at a pressure not exceeding 4 ounces at the company's meter. Upon request the company will have its engineers assist such a consumer in determining the size and method of installing the pipes from the meter to the appliances.

3. In the installation of a service line the gas company will make all necessary connections with its street mains and extend its service pipe to the inside of the curb line of the street, placing thereat a service cock and curb box free of cost to the property owner or consumer. The consumer or owner shall install and maintain a service pipe from the service cock to the meter but prior to turning on the gas the gas company shall have the right to inspect this pipe and refuse to turn on the gas if the pipe is not, in its opinion, properly constructed, fitted and laid. At the request of the owner or consumer the gas company may extend the service pipe from the service cock to the meter at the cost, however, of the owner or consumer who shall pay for the pipe, fittings and labor used in making such extension.

4. It shall be the duty of the owner or consumer applying for gas service, before notifying the gas company of being ready for the turning on of gas, to see that the pipe and connections from the curb box to the appliances are properly installed and all house lines and connections are properly tested and made ready for the setting of the meter. The house lines must be so installed and connected as to show no leakage under a gauge test of 3 pounds of air pressure over an interval of 10 minutes.

Consumer's Obligations

5. The service pipe from the service cock to the meter, together with the house lines, and the fittings and connections connecting same, shall be maintained in good repair and safe condition by, and shall be under the exclusive control of, the consumer or owner and the gas company shall have no responsibility for any imperfections therein or for any damage, injury or inconvenience arising from the escape of gas therefrom.

6. The consumer shall give advance written notice to the company before vacating the premises where gas is used or before discontinuing the use of gas for any reason and shall be liable for all gas passing through the meter until 48 hours after such notice is received by a duly authorized agent of the company.

7. An applicant for the installation of a service line or meter and, or for, gas service who is not an owner of real estate in the city or town in which he so makes application, must either furnish a guarantee of payment for such installation or service, signed by another party who owns property in the same city or town in which such installation or service is desired and who is satisfactory to the company; or must deposit with the gas company, as security, an amount to be determined by the gas company in accordance with Section 9334, General Code, Ohio Statutes. Such deposit or any balance thereof, if any, with accrued interest, will be returned to the depositor upon discontinuance of service by the consumer if the rules and regulations of the company shall have been complied with and all accounts with the company paid for.

8. The service line shall be connected to the main line in the street on which the building has its main entrance and is numbered, so that curb box may be directly in front of the building. Whenever practicable, the service line shall enter the building through the front wall. Should it be necessary to install a service through a side wall, the service line must be parallel to, and not further than 3 feet from the side foundation wall of such building. Service lines shall be installed with a view of accessibility in the event repair is necessary and shall not be laid in a sewer or water ditch or where the ground is not solid. (See Rule 9.)

9. The meter must be set close to the inside wall of the basement where the service enters, and at least 5 feet from any electric meter or switchboard, and at least 10 feet from any furnace or heating boiler or other heating appliance, and as near as possible to a window. There must be an unobstructed passageway leading to the meter. In case such passageway becomes obstructed, the gas company may discontinue supplying gas until the obstruction has been removed. Where there is no basement the meter must be located in an accessible, unobstructed, naturally lighted place, but in no case shall the meter be placed under stairways, or show windows, in closets, coal cellars, or in any room not naturally lighted and ventilated.

Company Supplies Meters

10. The meter for the measurement of the gas will be furnished by the company, and will remain the property of the company. In no case shall a consumer, his agent or employe connect or disconnect a meter. If any meter, or the pipes, fittings or connections supplying gas to such meter, be tampered with, the gas company may remove such meter and may discontinue the supply temporarily to such consumer from whose premises the meter is so removed, or to any other person tampering with such meter, until restitution has been made by payment for unregistered gas, as estimated by the company, and for any damage to the company's property, and at its option the company may discontinue service permanently. If the company so elects, before resuming service, it may require that a bond of not less than $100 and not more than $500 be furnished as a guarantee against further violation of its rules and regulations.

11. The consumer, after making proper application for gas shall notify the gas company when he desires gas turned on. In no case shall he or his agent or employe turn the gas on. The company may discontinue the supply of gas to premises where persons other than the company's authorized employes have turned on the flow of gas.

12. If, for any reason other than the fault of the gas company, its employe is unable to set the meter or to turn on the gas on first or second call at the consumer's premises, the consumer will be charged 50 cents for each additional call necessary to do the work.

13. The authorized agents and employes of the gas company shall at all reasonable times have free access to any premises supplied by the company and shall have the right to discontinue service and to disconnect and remove from premises the meter and any other property belonging to the gas company, for any of the following reasons or purposes:

a. To make repairs.

b. Nonuse of gas.

c. Nonpayment of bills for gas, materials, or service rendered.

d. Failure to furnish or maintain proper security.

e. Fraudulent representation or practice.

f. Violation of any rule or regulation of the company.

14. Each consumer shall immediately notify the office of the gas company of any insufficiency in the supply of gas. Any consumer noticing an odor of gas on or about his premises shall at once call the gas company's office in regard thereto; open the doors and windows of the building, extinguish all fires and lights and refrain from trying to locate the leak by using an open flame.

Regarding Safety

15. All appliances in which gas is consumed must be connected, with solid iron pipe and connections, or where such pipe and connections are impracticable, with a metallic hose, having screw joints, approved by the state fire marshal or his agent. Rubber hose **must not be used.** All gas appliances must have ample flue connections which should always be free from soot, ashes, or other obstructions, so that all products of combustion will be carried to the outer air. Solid dampers **must not be used.** All flues should be carried above the roof of the building in which gas is being used and the roofs of adjoining buildings where practicable. Where it is impracticable to erect flues or chimneys above the roofs of surrounding buildings a draft hood should be installed on each flue or chimney so erected. Consumers should be certain that the terms of this section are complied with before requesting that a meter be set or gas turned on.

16. All inspectors, agents, and other employes of the gas company are expressly forbidden to demand or to receive any gratuity from the customer for services rendered.

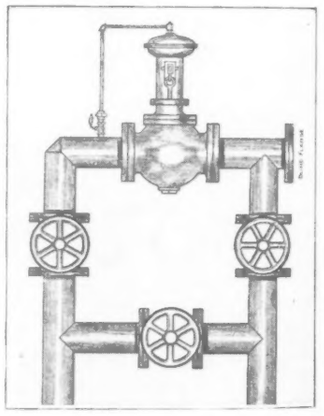


Figure 2

17. No meter reader shall inform a consumer of the amount of his gas bill. He shall, however, if requested by the consumer, give him the present reading of the gas meter.

18. If the supply of gas is discontinued for nonpayment of bills for service rendered, it shall not be again turned on until all such bills have been paid and the consumer has paid for the cost incurred in shutting off and turning on the gas.

19. If, at any time, in the judgment of the gas company, the service pipe, house lines, fixtures, or appliances on any consumer's premises, become defective or in a condition creating a hazard to property or life, the company, upon discovery of such condition, may discontinue the supply of gas to such consumer until such service pipe, house

lines, fixtures or appliances are repaired in a manner satisfactory to it.

20. The use of any compressor, booster, pump, blower, fan or other device, the effect of the operation of which, when attached or connected to a service house line supplying gas, is to artificially reduce (or tend to reduce) or disturb the gas pressure in the gas mains or service lines of the company, is prohibited, and the company reserves the right to discontinue the supply of gas to any premises where such a compressor, booster, pump, blower, fan or other similar device is connected or attached.

21. The following rules for piping houses must be observed:

a. The cellar line for houses not exceeding 10 rooms must be no smaller than 1½ inches, and larger houses in proportion.

b. All branch cellar lines are to be 1¼ to three-quarter inch, the three-quarter-inch branch not to exceed 6 feet in length.

c. All risers to heating stoves on the first and second floors should be at least three-quarter-inch.

d. Risers to gas ranges should be of the same size as the connections on gas ranges.

e. Risers for lights to be one-half-inch.

f. In case of a double house or terrace, where both parties have the use of one cellar, a manifold will be built and two meters set on the one service. If there are two cellars, it shall be piped for a meter in each cellar. Each cellar will have an independent service. In the case of apartment houses the pipe shall be located with reference to the public meter room.

g. No service line or house lines attached thereto supplying gas to any building shall be extended so as to furnish gas to any building located upon another lot nor so as to furnish gas to any other building upon the same lot where such other building is occupied by a party other than the one occupying the building directly supplied by said service line. The company reserves the right to discontinue the supply of gas to any service or house lines attached thereto which has or have been so extended until such extension or extensions have been removed.

Size of Pipes

22. The following rules, based on cubical contents and, or number of rooms, shall govern the size of service pipes to private residences:

No Rooms	Cubical Contents
4 or less	7,000 or less
	8,000 to 13,000

No Rooms	Cubical Contents
8 to 10	14,000 to 19,000
11 to 13	20,000 to 24,000
14 to 20	25,000 to 35,000
21 & up	36,000 to 39,000
21 & up	40,000 to 49,000
21 & up	50,000 to 65,000
21 & up	Over 65,000

23. In no case shall an artificial gas line be connected with, or tied into a natural gas line; nor shall any method be used by which both natural and artificial gases may be used interchangeably.

24. The gas company reserves the right to modify, alter or amend the foregoing rules and to make such further and other rules and regulations as experience may suggest and as the gas company may deem necessary or convenient to the conduct of its business.

Regulators

1. In order that the gas may be reduced from the pressure carried in the main transmission lines to a safe pressure for connecting the house lines it is generally necessary that it be reduced by at least three stages. It is customary to make the first reduction of pressure at some point near where the town line leaves the transmission line.

2. The second reduction is made at a point near the town border and the last one at one or more points in the distributing system as may be necessary to give the service desired.

3. Owing to the higher vapor content of high-pressure gas it is usually necessary to provide heat in some manner to prevent both the high and intermediate-pressure regulators from freezing. It requires very little ice to cause the regulator valve guides to adhere to the valve seat sufficient to prevent the proper functioning of the regulator.

The most effective means of applying heat to a regulator is to securely weld a larger pipe about 6 feet long over the one carrying the gas into the regulator and to provide a side opening near the regulator to serve as a flue connection, the other end being left open. A brick or sheet steel fire box is provided over this outer open end and a burner is so located in it that the flames can never come in contact with the gas-carrying pipe. The heated products of combustion form a heat envelope entirely surrounding the line for a distance of 6 feet or more as desired. The end of the heating chamber and the vent pipe may be safely extended any distance inside the building. This is a decided advantage for two reasons. The radiated heat keeps the regulator house slightly warmed, and the vent can be provided with a down draft tube which serves to prevent the fire being smothered out. A sketch of such an installation is shown herewith Figure 1.

There is no such need in connection with low pressure regulators. After the gas has been expanded from ordinary line pressure to intermediate pressure for transporting to the various district regulators in a city plant the humidity is only from 10 to 30 per cent and the cooling caused by the farther expansion to ounce pressure is not sufficient to cause the precipitation of moisture.

While there are no rigid requirements, there are almost as many different standard regulator set-ups as there are gas companies. There are some very good reasons why some of them are better than others. No attempt will be made to illustrate or discuss any but one type of setting. Most every one will concede that it is necessary that all town plant regulators should be provided with a bypass. It is seldom necessary that the bypass be as large as the pipe size of the regulator since its capacity is computed at the pressure on the inlet of the regulator. By referring to Figure 2 it will be seen that with the arrangement shown the regulator is rapidly accessible either for replacement or repair. The blind flange which is easily removed from the inlet side affords easy access to the screen and a means of blowing back through the regulator to dislodge any foreign substance lodged therein. The inlet then may be easily removed if necessary for better examination or removal of the valve. This is not possible when the regulator is connected straight in the line.

(a)

	Diameter of pipe for Following length of services	
	100′	150′
1¼″	1¼″	1¼″
1¼″	1¼″	1¼″

(b)

	Diameter of pipe for Following length of services	
	50′	100′	150′
1½″	1½″	1½″	1½″
1½″	1½″	2″	2″
1½″	2″	2″	2″
2″	2″	2″	2″
2″	2″	2″	3″
2″	3″	3″	3″
3″	3″	3″	3″

Pressure Variation

4. It has been stated repeatedly that better service can be given the consumer by a uniform pressure of from 2 to 4 ounces per square inch than by a higher pressure, particularly if the higher pressure is not constant.

There has been a decided effort made to narrow the limits of pressure variation in low pressure distribution mains. A maximum variation of 1 inch of water pressure, slightly over one-half ounce per square inch, is the standard of performance set by some large distributing companies. It is very difficult to get regulation to this degree of exactitude by the use of a regulator of the conventional type, in which the diaphragm is connected directly to the valve stem, without the use of some auxiliary apparatus. The variation in the effective diaphgram area with valve opening unbalances the weighted lever causing a corresponding change in the pressure which is commonly referred to as diaphragm effect.

(a) There are several forms of auxiliary apparatus used to increase the sensitiveness and accuracy of the pressure control by the use of this type of regulator. Perhaps the oldest and best known type of apparatus for this purpose is the fluid filled gasometer type sensitizer which is connected in some manner to the end of the regulator lever. This apparatus met with considerable disfavor some years ago, because of the danger connected with its use in the event the control line should be broken in any way or the tank develop a leak and release the sealing fluid. This objection has been entirely overcome in recent practice by which the control line is so connected and the bell so attached to the regulator that in the event of failure of the sensitizer for any reason the pressure will be slightly increased rather than decreased as was the case with the former objectionable type. This same hook-up is made in such a way that it does not in any way interfere with the automatic shut-off arrangement which is depended upon to cut off the flow of gas in case of a temporary failure of the supply.

(b) For this same purpose a device has been in somewhat limited use by means of which the weight on the regulator lever is caused to move from one predetermined position to another dependent on the amount of gas flowing. In this manner the pressure can be boosted to compensate to a certain extent for line friction between regulator and consumer.

(c) A pilot governor arrangement by which a small sensitive pilot regulator controls the pressure which is exerted on the top of the main regulator diaphragm has been used very effectively for this purpose. The arrangement is illustrated in Figure 3.

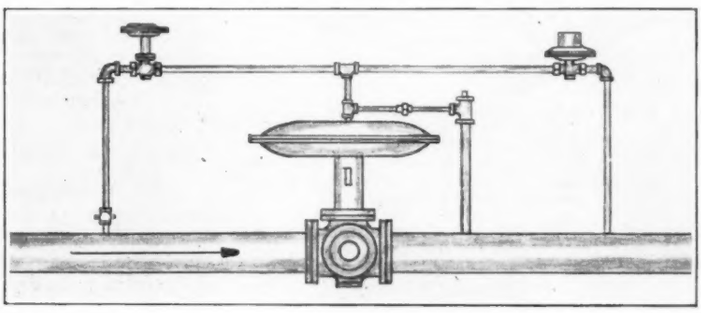


Figure 3

Safety Valves

(d) In connection with all regulators controlling the pressure on the line on which the consumer depends for his constant supply of gas, it is very desirable that means be provided whereby gas can escape to the atmosphere in the event of excessive pressure due to failure of the regulator. It is difficult to obtain satisfactory weight loaded safety valves sufficiently gas tight to serve for this purpose. For this reason some form of fluid seal has been adopted quite generally for this purpose. These seal tanks are usually made of 6-inch or 8-inch pipe with a small line usually 2 inches extending through the top almost to the bottom with the bottom end left open. The tank is filled with fluid to a sufficient depth, so that the head of fluid above the open end of the small inner pipe is sufficient to withstand a pressure somewhat higher than the maximum peak pressure in the low plant. Occasions for the gas breaking through the fluid seal are very few, and it is not customary to make any provision by which the fluid blown from the seal will drain back into the tank, to make the seal self-restoring. Kerosene or other light oil is usually used for this purpose.

5. In order that the company may have a permanent continuous record of the pressures carried in a low pressure distributing plant, it is very necessary that one pressure recording instrument be installed in each town plant. Usually it is found desirable to have a recorder of this type in the office of the local manager or agent, so that he may have before him an indication and permanent record of the pressure carried. A similar recording instrument should be placed in one or all of the district regulating stations. The record so obtained gives an additional check on the performances of the regulator, and serves as a check on the record obtained in the office. In view of the fact that the records so obtained have a decided bearing on possible damage claims it is a beholden on the company to preserve them for a considerable length of time.

The public expects and has every right to demand continuous and uniform service. Even a momentary failure of the gas supply, if followed by a resumption of service, is very likely to end in disaster. The gas escaping from the burners after the fires have been put out by a temporary failure of the supply may cause either fatal accident or serious explosion. It is considered best practice in case of an accidental or temporary shut-off to leave the gas off until each customer has been notified, or the gas shut off at the curb.

Meters

1. The meters used by a distributing company are often quite correctly referred to as the company's cash registers. If natural gas were a commodity which could be bought and sold over a counter in the same manner as we procure our groceries for daily use, a great deal of attention would be given to the accuracy of the scales being used, it is not unusual to see gas companies purchase meters, which are the scale by which their commodity is to be sold, without sufficient consideration of the fitness of the meter for the particular job at hand. If we were going to sell an amount of fine merchandise having a value equivalent to the amount of gas sold and use the same methods by which we sometimes see large quantities of gas measured, we attempt to determine its value by weighing it on a steel-yard. Before selecting a proper meter for any particular service the conditions under which the gas must be delivered and measured must be carefully studied.

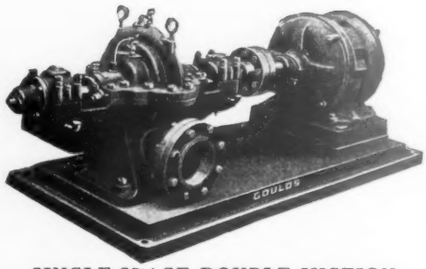
In order that the company may not be required to sustain any leakage in consumers piping it is a good policy to insist that all meters be located either at the end of the company's service line or as near as possible to it. Rural consumers meters, where possible, should be located at the tap.

Industrial Meters

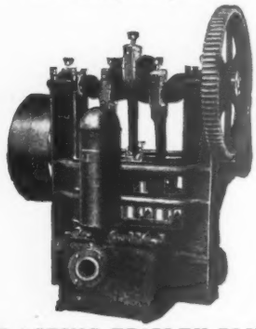
The sale of gas for industrial purposes presents the most difficult problems of this kind, because of the very wide range of flow during different periods of the day or week. It is necessary that means be provided for accurately measuring the relatively small quantity of gas used for heating and other miscellaneous small uses during periods of comparative inactivity of the plant, and at the same time provide means whereby an equally accurate measurement can be made of the larger quantity used during full plant operation. This type of measurement is mentioned first, because it is the most difficult and the same methods used in determining the proper meter for this purpose when applied to the different operating conditions serve equally well for any purpose. Where the minimum rate of flow is such that an easily readable

A Complete Pumping Service for the Natural Gasoline Plant

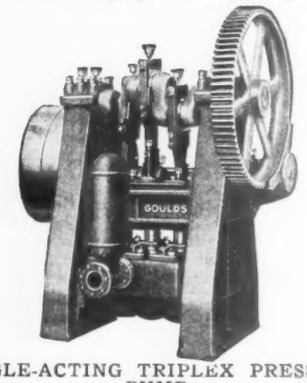
Pumps for: High and Low Pressure Gasoline and Naphtha Work--Spray and Respray Service--Charging and Feeding Stills--Circulating Cooling Water for Engines, Compressors and Condensers.



SINGLE-STAGE DOUBLE-SUCTION CENTRIFUGAL PUMP
Figs. 3065, 3075, 3085, 3095.
For condenser service, gas engine and compressor jacket cooling in both compression and absorption plants.



SINGLE-ACTING TRIPLEX PLUNGER TYPE
Fig. 1696
For main charging in absorption plants.



SINGLE-ACTING TRIPLEX PRESSURE PUMP
Type of Fig. 997-E and Fig. 1671
For high pressure gasoline work in compression plants.

Send for These Special Oil Pump Bulletins

To provide accurate data showing the adaptability of Goulds Pumps for pumping oils, GOULDS PUMPS, Inc., in collaboration with the Union Oil Co., conducted a series of tests in the Los Angeles Refinery of the above Company. The result of these tests are given in two reports by Prof. Robert L. Daugherty:

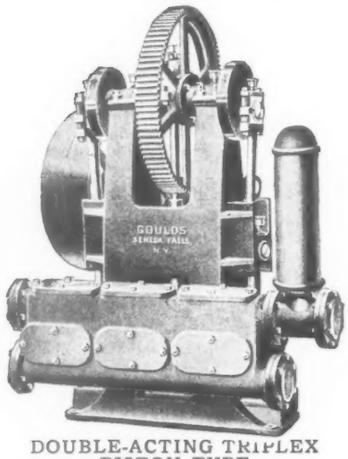
Bulletin 126. Investigation of the Performance of Centrifugal Pumps When Pumping Oils.

Bulletin 130. A Further Investigation of The Performance of Centrifugal Pumps When Pumping Oils.

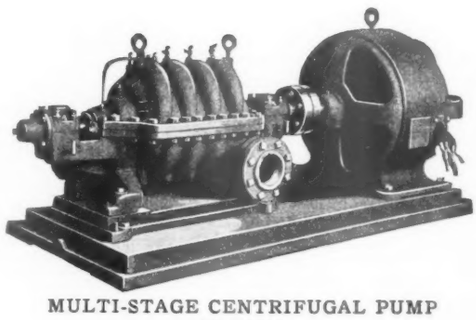
"Petroleum Industry and Pumps Used," printed by Lefax, summarizes the uses for pumps for pipe line, refinery and natural gasoline plant services.

It is one of 13 Data Booklets issued by Goulds for distribution to engineers.

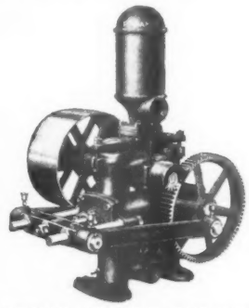
Copies sent free on request.



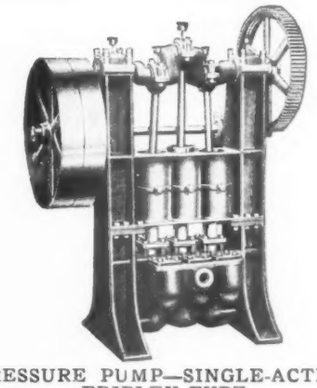
DOUBLE-ACTING TRIPLEX PISTON TYPE
Fig. 1357
Naphtha and gasoline Transfer Pumps in compression plants. Pressures 75 to 125 lbs.



MULTI-STAGE CENTRIFUGAL PUMP
Fig. 3330
For main charging in absorption plants.



DOUBLE-ACTING SINGLE CYLINDER TYPE
Fig. 1531
For naphtha and gasoline low pressure work in compression plants. Pressures up to 75 lbs.



PRESSURE PUMP—SINGLE-ACTING TRIPLEX TYPE
Fig. 1713
For high pressure naphtha work in compression plants. Pressures up to 750 lbs.

GOULDS PUMPS, Inc. Seneca Falls, New York

NEW YORK 16 Murray St. 19 Park Pl. | PHILADELPHIA 111 No. 3d St. | BOSTON 177 High St. Fort Hill Square | CHICAGO 12-14 So. Clinton St. | PITTSBURGH 636 H. W. Oliver Bldg. | ATLANTA Citizens and Southern Bk. Bldg. | HOUSTON 1402 Second National Bk. Bldg. | TULSA 705 Kennedy Bldg.

GOULDS PUMPS

record cannot be obtained by the use of one orifice meter, it is customary to provide a manifold containing two or more such meters either manually or automatically controlled. The expense involved in manual control of this kind is so great that it is usually found more economical to install automatic means for turning on and off the additional meters. If the minimum rate of flow is so small that it is impossible to obtain an accurately readable record of the gas used at a minimum flow a very satisfactory measurement can be made by the use of a positive meter of large capacity arranged in connection with an automatically controlled orifice meter in such a manner that when the rate of flow reaches a predetermined maximum value the orifice meter or meters connected in manifold with it are automatically opened up. The flow of gas is then divided between the two. The reverse operation takes place when the plant is shut down and the rate of flow becomes comparatively small. Equipment of this kind has been operated successfully where one positive meter was used as a means of measuring the small flow and as a means of controlling two orifice meters each connected in series with an automatic differential valve.

Where the rate of flow does not vary through such wide limits, as for example, at glass plants which are operated continuously or on partially reduced schedule over week-ends, the measurement can be very satisfactorily made by the use of two orifice meters only one of which need be automatically controlled. It is very rare, indeed, that a satisfactory measurement can be made to an industrial consumer by the use of a single orifice meter.

The Electric Meter

If it is desirable to use a meter of entirely different operating principle, a very satisfactory measurement can be made by the use of a Thomas electric meter, such as manufactured by the Cutler Hammer Manufacturing Co. The use of this type of meter, however, is dependdnt upon the availability of a continuous supply of electrical energy. The first cost is very much higher than for orifice meter equipment of the same capacity and for these reasons its use has been very limited. In the two installations of which the writer has had personal knowledge, the Thomas meters were each checked by one or more orifice meters through which the same gas passed. In each case the agreement between the two types of measurements differing as they are so widely in principle was very little. It was, however, necessary to make very careful correction for the variation in flowing temperature and specific gravity as effecting the orifice meter and in the variation of specific heat as indicated by the variations in gross heating value as effecting the electric meter.

Commercial Meters

2. The next class of consumers demanding careful selection of meters are those which are ordinarily classed as commercial. This embraces all kinds of small shops, bakeries, laundries and similar industries. These consumers all requiring comparatively small quantities of gas demand more attention than the larger ones. For this reason care must be exercised in selecting meters which can be depended upon for accuracy and which are of ample size to measure the maximum requirements of the consumers without dangerously overloading the meter. In the event consumers of this class are supplied with gas taken directly from a medium or higher-pressure line it is essential that great care be exercised in the selection of the meter, and in the arrangement of the meter and regulator, so that it would be impossible for the consumer to change the pressure at which the gas is being measured. In the event that it is not practical to make this arrangement a pressure recorder should be provided, so that an actual record may be obtained of the pressure of the gas as measured. The best method by which the company may be assured that the consumer will not increase the pressure on his meter beyond the predetermined limit is to provide the meter setting with a safety valve or fluid pressure seal connected to the outlet of the meter in such a manner that should the pressure exceed a certain maximum amount the gas will escape to the atmosphere. If the performance of this safety appliance is explained to the consumer it is not likely that he will permit gas for which he has paid to escape in this manner.

Domestic Meters

3. In selecting meters for either of the former classes it is contemplated that they may have more or less regular inspection but the conditions of use of domestic meters is quite different. While it is usual practice with most companies to regularly inspect all domestic meters at intervals of varying length they must be relied on to retain their accuracy for relatively long periods. In selecting meters for this service it is necessary that consideration be given to the following points.

1. Adaptability to the particular needs of the company.
2. Continued accuracy. (Length of time original adjustment is retained.)
3. Economy of operation.
4. Economy and simplicity of repair.
5. Convenience of adjustment.
6. Weight per unit of capacity as effecting expense of connecting and changing.
7. Speed of operation per unit of capacity as affecting wear of moving parts.
8. Type of diaphragm, whether pressed or sewed and the kind of leather used.
9. Whether diaphragm is depended on as a gasket.
10. Convenience of means of sealing.
11. Location of valves in top or bottom of meter.

While it is desirable to have meters of moderate speed in order that the wear may be reduced to a minimum, yet if reduced speed is obtained by the addition of excessive weight requiring two

Manufactured Gas as Supplement

Solves Problem in Localities Where Population is Concentrated Sufficiently to Warrant Big Expense Involved

By Thomas R. Weymouth
President, Iroquois Gas Corp.

In some of the older natural gas fields practically all of the gas producing territory has been developed and there is little new production available. In spite of this, the demand for gas increases with the increase in population, and when it exceeds the supply the companies are confronted with a serious problem. In those localities where the population is concentrated in cities of sufficient size to warrant the large capital investment required for the installation of artificial gas plants, the solution of this problem is relatively simple. But there are many companies serving a scattered population where the substitution of artificial gas for natural is entirely out of the question. These remarks are intended to apply only to those cases where a supply of artificial gas to supplement the natural supply is fully justified by the facts in the case.

With this in mind, the first question to be asked is what kind of artificial gas shall be manufactured. There are several kinds available, the most prominent of which are coal gas, coke oven gas, blue water gas, carburetted water gas, producer gas and oil gas.

Coal Gas

Coal gas is derived direct from bituminous coal by distillation in a closed retort, the gas being driven from the coal and carrying with it tar and ammonia, which are recovered and sold as by-products, leaving a coke residue in the retorts. The coke is sold direct as hard fuel, or may be used as a raw material for the manufacture of water gas. The heating value of the coal gas produced by this process is under control and may be varied from 500 B.t.u.s up to 650 or more B.t.u.s per foot. The specific gravity of the gas is about 0.42. Best results are secured when the production of gas is carried on at a fairly uniform rate, and the success does not lend itself readily to intermittent operation.

Coke Oven Gas

Coke oven gas is essentially the same as coal gas except that it is produced in ovens, or retorts of a different type, and usually from coals of somewhat different characteristics—the principal product with ovens being coke of certain specified properties, the gas being a by-product, whereas with coal gas retorts, a specified kind of gas is the principal product with coke as a by-product. The manufacture of coke oven gas is also essentially a continuous process with little flexibility in rate of production.

Blue Water Gas

Blue water gas is produced by passing live steam through incandescent coke. This is an intermittent process, the coke first being made white hot by forcing a blast of air through it, after which the air is shut off and the steam passed through. The gas produced in this manner has a heating value of about 290 to 300 B.t.u.s per foot and a specific gravity of about 0.55. The intermittent character of this process renders it extremely flexible and blue gas is therefore well adapted to providing for peak load demands of a gas service.

Carburetted Water Gas

Carburetted water gas is simply blue gas with the addition of gasified oil, which raises the heating value of the blue gas from 290 to whatever point may be desired, depending upon the amount of oil added. This process has the same flexibility of output as blue gas, but is more costly.

Producer Gas

Producer gas is the result of the incomplete combustion of hard fuel, such as coal or coke, and is made by passing steam and a limited amount of air through the burning fuel bed. The gas has a heating value of about 135 B.t.u.s per foot, and a specific gravity of about .87. Producer gas is not as desirable as the other gases mentioned for supplementing a natural gas supply, owing to its low heating value and the difficulty of cleaning it.

Oil Gas

Oil gas is made by destructive distillation of fuel oils. There are several processes for doing this and the characteristics of the gas depend upon the particular process by which it is produced. Some of these oil gas processes are flexible and from this standpoint are well suited to the requirements of a supplementary supply of natural gas.

The supply of artificial gas, of whatever kind or by whatever process it may be made, is never as flexible as a natural gas supply, and the lack of coincidence between the more or less steady rate of supply and the widely fluctuating rate of demand makes it necessary to use storage holders for artificial gas, whereas with natural gas the storage capacity of the high pressure pipe lines and the flexibility of control of the gas wells render storage holders entirely unnecessary. The notion sometimes prevails that holders should be used in natural gas systems where the gas supply has fallen below the peak demands. This is entirely an erroneous idea, however, due to a lack of understanding of the fundamentals of the problem. Holders cannot create an additional supply of gas. Their sole function is to equalize a widely fluctuating hourly demand for gas with a different, and usually a steady rate of production of gas. For instance, during the small hours of the night the demand for gas usually drops to a small fraction of the average daily deliveries, while during the day, and particularly at meal hours, the rate of delivery is considerably larger than the average. In the meantime, the gas holder permits the manufacturing plant to maintain a steady rate of production of gas, day and night. During the night time, the excess of production over the gas being drawn from the mains by the consumers is delivered into the holder, and when the heavy demands come on at meal time, the holder and manufacturing plant together deliver their gas into the mains at a rate much greater than the plant alone is making it. Thus, the holder acts as a surge tank on the lines.

Holder Simply a Surge

If the average daily demand for gas should exceed the total daily capacity of the manufacturing plant, however, the holder itself would not correct the deficiency in supply. If it were large enough to hold several days' or weeks' supply until the seasonal demand were to decline to a point below the seasonal average capacity of the plant, the supply stored in the holder which has been depleted by the protracted drain could then be replenished. Obviously, this would require a holder of such huge dimensions, or so many holders that the cost would be prohibitive. The only real solution is to add more manufacturing plant.

This is the situation that confronts some natural gas companies today, but unfortunately there are not available to them additional sources of natural gas. Holders will not help them, but artificial gas manufacturing plants will. And when they build these plants holders will be a necessary part of them—but only to provide the necessary equalization of hourly peaks, and not for seasonal ones.

When holders become necessary there are three general types available. For small plants, and especially for natural gas systems where high pressures are used, a spherical type of holder permits the storage of gas in small space, for the actual mass of gas it will hold is equal to its volume multiplied by the number of atmospheres to which the gas is compressed. These holders have no moving parts.

Ordinary Type of Holder

The gas holder with which most people are familiar consists of a tank of water containing another smaller but similar tank turned upside down, and mounted between guides so that when gas is fed into the space over the water and under the bottom of the inverted tank, the latter will rise between the guides and make room for the storage of the gas. In order to increase the capacity of the holder there are usually concentric rings of sheet metal surrounding the inverted tank, and lifted with it as it rises just like a huge telescope, with the joints water sealed. Holders of this type have been built with a capacity of as much as 15,000,000 feet of gas.

A new type of holder has been developed in Germany during the last eight or nine years and during the last two or three years several have been constructed in this country. This consists of a single tank the full size of the maximum holder capacity, containing a piston which slides up and down within the tank, and floating on top of the gas. The sliding joint between the piston and the wall of the tank is sealed by tar which is pumped from pumps at the bottom to the top of the piston. These holders are also built in capacities up to 15,000,000 feet.

men to hang the meter in the piping the purpose has been to a certain extent defeated.

All meters with the pipe connection on the top should be supported on a sling or shelf so that the weight of the meter may not be on the connections.

4. Method of testing.

Since gas is universally sold throughout the English-speaking world by the cubic foot it is natural to expect that the standard unit of measure for all meter testing is a vessel holding but one exact cubic foot. It is called a cubic foot bottle. The larger commercial apparatus used for the testing of meters is called a meter prover. Very complete rules governing the use of both have just been issued in a circular on Gas-Measuring Instruments, Circular No. 309, by the United States Bureau of Standards, which reads in part as follows:

Standard Gas-Meter Provers

The prover tank is preferably made annular, so that a minimum amount of water or oil will be needed to fill it. This design also permits the prover to assume the room temperature more rapidly, allows more rapid filling and emptying, and makes the whole outfit lighter. On the other hand, the annular tank is more difficult to clean and repaint.

The bell is usually made of copper or galvanized iron. The copper bell, though initially more expensive, is considered by some to be more economical because of its great resistance to corrosion. It is also claimed that a copper or brass bell has the advantage in that if kept well polished and slightly oiled practically no water will adhere to its surface and the temperature change due to evaporation from the surface of the bell, is reduced.

Communication with the confined space under the bell is secured by a tube which extends from above the surface of the sealing fluid, under the bell, down to the bottom of the tank, out and up along the outside of the tank to a convenient height, where it terminates in the valves which control the passage of air to or from the prover.

There are two methods which are used to decrease or prevent temperature changes in the bell due to evaporation from its surface when raised. One method is the use of the covered bell prover. These covers prevent air currents from striking the bell and make it possible to maintain nearly uniform temperature in the bell. **The other method is to use a light oil in the prover tank.**

The prover should preferably be raised above the floor by legs with screw feet. This facilitates leveling of the apparatus, and it reduces the lag of the temperature of the prover behind that of the room by allowing free circulation of air under the prover. This construction also lengthens the life of the prover by preventing the corrosion which results from the accumulation of moisture on the underside of the tank.

The scale may be fastened to the bell and the pointer located on the tank, or the scale may be placed on one of the pillars which carry the bell support and the pointer attached to the top of the bell. A dial is sometimes used instead of the usual straight scale and pointer; the indicator being mounted by a friction joint on a drum which is rotated by a fine wire attached to the top of the bell. Having the scale attached to the bell is considered the best practice, since in this way the same scale divisions will apply to the same portions of the bell at all times.

Equipment of Prover

The equipment of a prover should also include two thermometers and a pressure U gauge. One of the thermometers should be mounted about half way up one of the prover pillars and at such a distance from the operator's position that his presence will not influence it. This thermometer indicates the temperature of the air about the prover. The other thermometer is suspended in the sealing fluid between the bell and the tank. The pressure U-gauge should be connected to the prover outlet beyond the outlet cock. In this position it will indicate the pressure of the gas delivered by the prover to the instrument under test. A convenient location for the gauge would be on one of the pillars at about level of the operator's eyes.

There are a few points that it is well to observe in the location and care of a prover. The special precaution as to its location is to select a **well-lighted room in which the temperature changes will be small and the air comparatively still. Temperature changes greater than 5 to 10 degrees Fahrenheit should not occur during a period of 24 hours if they can be avoided, since it is essential that the prover and the meters to be tested be as near the same temperature as possible. A difference of 3 degrees Centigrade or 5 degrees Fahrenheit between the prover and the meters under test may cause an error of more than 1 per cent. For this reason the prover should not be near a radiator, steam pipe, or hot or cold air ducts.** It must be protected from drafts and direct sunlight should never be allowed to fall on the prover or the meters under test. As the temperature of the prover usually lags behinds that of the room it is desirable to provide convenient means for changing the temperature of the fluid in the prover tank. This is commonly done by adding hot or cold water, steam or water when water is used in the tank, and by steam pipe coils or inclosed electric heating coils when oil is used in the tank. In any case the fluid should be thoroughly stirred before taking its temperature.

There are two sets of weights counterbalancing the weight of the bell. The main counterweight hangs on a chain which passes over a large grooved wheel and is fastened to the center of the top of the bell. The second counterweight is suspended from a grooved spiral which is fastened to the same shaft as the grooved wheel. The function of the main weight is to provide a way to change the pressure of the gas within the bell. The function of the secondary weight is to counterbalance the increasing buoyant effect of the sealing fluid as the bell descends. The spiral is so attached that as the bell descends, the radii to the successive points at which the cord leaves the spiral, continually shorten; thus the turning moment or counterbalancing effort produced by the secondary weight, as applied to the bell through the grooved pulley and main weight chain, decreases. The amount of the secondary counterweight should be such that **the gas in the bell is at a constant pressure irrespective of the position of the bell.** If this is not the case the correct amount of the secondary weight may be determined by the following manner: The main counterweight is increased until, with the prover valve open, the bell will neither rise nor fall of itself. The bell is then moved to another position and if it does not remain stationary the spiral counterweight should be increased or decreased as the conditions may require, the main counterweight being simultaneously decreased or increased until the bell will remain at any point with the valve open. The main counterweight may then be decreased until the pressure within the bell is the desired amount, usually equal to 1½ inches of water.

The chains or cords supporting the counterweights should be flexible and run freely over the wheel and spiral.

It is necessary to arrange at one side of the prover a bench or table on which meters may be placed during the test, preferably with the test dial at about eye level. If one man uses two provers the bench may be placed between them and the two meters under test at any one time are thus within easy reach of the operator.

The hose for connecting meter and prover should be conveniently supported in such a way that when disconnected from a meter it will remain free from sharp bends. This is usually accomplished by having the hose rest in a saddle suspended from an overhead support. However, the saddle should not be wider than the hose, for if it is the hose may flatten over the saddle and crack. When a considerable number of meters must be tested a device for rapidly connecting the meters with the prover is very desirable.

The valves of the prover should be kept free from dust and be well greased at all times. Any grit in the valves will soon scratch the bearing surfaces and cause leaks. When not in use the circular slide valve should be covered to keep out the dust.

Although all provers are carefully tested by the manufacturer before shipment they must be again examined after being set up for use to insure that they have not been damaged in shipment.

The prover bell should first be raised and carefully examined to make sure that it is not dented. The counterweight should then be adjusted to produce a very small pressure, the air allowed to escape, and the fall of the bell noted to see that it is easy and regular and free from excessive friction in the guides and bell-lifting mechanism. The difference in pressure within the bell with the air escaping and with it confined should not exceed 0.1 inch of water pressure. The prover should be tested for leaks by leaving the bell filled with air under a pressure of 2 or 3 inches and observing whether there has been any escape of air after a period of an hour or more, making the necessary corrections for any changes of temperature, pressure, and vapor pressures which may have taken place.

Calibration of Gas-Meter Provers

For the standardization of a prover it is essential to have the temperature of the room constant throughout the test, and with some operations it is a great advantage to have the air of the room saturated with moisture. To prevent temperature changes occurring, drafts must be excluded. In some laboratories the air of the room is kept nearly saturated by sprinkling the floor with water and hanging wet sheets in the room. It is not always necessary to saturate the air in the room if care is taken to saturate the air used in the test before it is measured and to prevent temperature changes due to the evaporation of water from the outside of the bell.

The calibration of the prover by the cubic-foot bottle can be made either by measuring the air into the prover 1 cubic foot at a time until the prover is filled, or by filling the prover and measuring the air out of 1 cubic foot at a time. The latter method has several advantages, especially if a cabinet type of bottle is employed. It is often recommended that in every test of a prover comparisons be made by both methods. It is unquestionably best to make both forms of comparison the first time that a prover is tested, but after a first test it is not necessary to calibrate again by more than one method. There is no inherent reason why the two methods should not agree, and if a discrepancy is found it must be due to some experimental errors. Successive calibrations should agree with each other within 0.3 per cent.

The bottle and prover should be kept near together for a long enough period before the test, preferably overnight, so that they will be at the same temperature. During this time the prover bell should be raised as far as possible without unsealing it, if water is used as a sealing fluid, so that the air in the bell will be fully saturated with water vapor

MIXING NATURAL AND MANUFACTURED GAS IN CINCINNATI IS A SUCCESS

By H. C. Blackwell
President and General Manager, the Union Gas & Electric Co.

Natural gas was first made available in Cincinnati in 1905, at which time a pipe line was extended into that community by the Ohio Fuel Gas Co., resulting in competition for a short time in a small district with the manufactured gas service, rendered by the Cincinnati Gas & Electric Co. At the same time, arrangements were being completed by the local gas company for discontinuing the supply of manufactured gas and furnishing natural gas in its stead. This became a reality in July of 1906, when the pipe line of the Cincinnati Gas Transportation Co. was placed in service and delivered to the Cincinnati company a supply of natural gas, purchased from the Columbia Gas & Electric Co. of West Virginia.

After some 10 years of supplying the community with natural gas service, it was concluded that the abnormal peak loads on the transmission pipe lines, brought about in cold weather by the house heating consumption, could be partially offset by mixing manufactured gas with the natural gas—the nature of these peak loads was such that the manufacturing plant must be quite flexible and capable of lending itself to wide variation in output.

Producer Gas Plant

A producer gas plant was decided upon with a daily capacity of 10,000,000 feet and was placed in service in December of 1917, since which time a mixed gas service has been rendered in Cincinnati. In 1925, four 12-foot water gas sets were installed, having a daily capacity of 20,000,000 feet of carburetted water gas, or 12,000,000 feet of blue gas. Consequently, the company may make use of producer gas, carburetted water gas or blue gas, or any combination of these three gases for mixing with natural gas as circumstances may demand.

The mixed gas supplied in Cincinnati has a uniform heating value of 900 B.t.u. per foot. Gas is mixed at three locations quite widely separated, each mixing station delivering its output to a medium pressure belt line, encircling the greater part of the territory served, this belt line, in turn, delivering gas through pressure reducing stations to the low pressure distributing system.

Cincinnati has in excess of 7,000,000 feet of storage holder capacity; and although many tests have been made under all kinds of weather conditions, we have never found indications of gas stratification in either the holder or the distributing system, and have never found instances where the service rendered would indicate a separation of the gases after being mixed.

Mixing Devices

The mixing devices are rather simple sheet steel, cylindrical tanks approximately 8 feet 6 inches in diameter by 8 inches high, the artificial and natural gas entering the tank at right angles, causing the gas to set up a whirling motion which seems to produce a complete mixture. The outlet is either on the top or bottom of the tank, as conditions might warrant.

Both natural and manufactured gas are admitted to the mixing chamber, at from 4 pounds to 10 pounds pressure, according to the demand on the system—both gases are measured before entering the mixer.

A Thomas recording calorimeter is installed at each of the mixing stations as a guide in maintaining the resultant mixture. These are checked several times each day with a Junker calorimeter.

Specific gravity of the mixed gas varies from .658 to .729, depending on whether the mixture is the result of the use of blue gas, water gas or producer gas.

One disadvantage in the mixing of gases is that, as yet, there are no instruments on the market which will make instantaneous records of changes in B.t.u., and this lack of instruments makes necessary very close attention on the part of the operator. It is our understanding, however, that we may soon look for a recording instrument designed to overcome this difficulty.

On the whole, the mixing of natural and manufactured gas in Cincinnati has been a complete success.

LUDLOW VALVES

THROUGHOUT the oil industry you will find huge quantities of LUDLOW Valves. They are used at the wells, in the gas lines, in the pipe lines, in the natural gas plants and in the refineries. You will find too, that the largest companies have standardized thereon. This preferment is indicated because of their extremely satisfactory service. LUDLOW costs a little more—but are much cheaper than imitations because of their unusually long life of service.

PIONEERS—AND THE FIRST TO BUILD

LUDLOW is the pioneer in valve manufacture. Today they are the largest and the oldest-established producers in the world. Large quantities of all sizes and kinds for any pressure are maintained at the factory—and ample stocks are carried by the distributors to supply your every need promptly and satisfactorily.

TRADE LUDLOW MARK

THE LUDLOW VALVE MFG. CO.
TROY, NEW YORK

KANSAS CITY CHICAGO BOSTON PITTSBURG

LARGE STOCK MAINTAINED AND REAL SERVICE OBTAINED FROM →

Mid-Continent Supply Co., Fort Worth
Harrisburg Pipe & Pipe Bending Co. of Texas, Houston, Texas
Peden Iron & Steel Co., Shreveport, La.
Henderson Iron Works, Shreveport, La.

MADE IN THE SHOPS NEAREST THE OIL FIELDS

Steadfast Unfailing Quality

The beacon sending forth its penetrating light the symbol of dependability compares to the steadfast unfailing quality of Norris Swedge Nipples and Bull Plugs. The care with which these Norris Quality fittings are made and their dependability in service has created a world demand.

Norris quality does not vary, the thousands of Norris Swedge Nipples and Bull Plugs in use throughout the world by the major companies is your assurance of satisfying service. Norris Quality costs no more and pays big dividends in service.

W. C. NORRIS, *Manufacturer*
Tulsa, Oklahoma

Branch Warehouse Fort Worth, Texas

Republic Supply Company of California
Pacific Coast Distributors

At All Leading Supply Companies
Mid-Continent

W. C. NORRIS
MANUFACTURER

NORRIS QUALITY PRODUCTS

and the outside of the bell will be dry before the beginning of the test. The bottle, while empty, is connected with the prover and the connections tested for tightness by opening the valve between the bottle and the prover until the pressure in the bottle is the same as that in the prover. The prover valve should then be closed and the set-up allowed to stand for 5 or 10 minutes to test it for leaks. If the temperature of the gas (or the air) and prover does not change the pressure within the bottle and connections, as indicated by the gauge on the prover connection, should remain the same during the interval. If it does not do so a leak in the bottle or the connections is indicated.

1. Calibration of a Prover with an Immerson-Type Bottle: (a) Bottling out of the prover. Bottling out of a prover with an immersion bottle may be done either at atmospheric pressure or at the usual prover pressure. Assuming first that the calibration is to be made at the usual prover pressure the procedure is as follows: After making sure that all connections are tight, as described above, and with the bell raised as high as possible without unsealing, the valve between prover and bottle is opened, thus making the pressure within the bottle the same as in the prover. The quantity of liquid in the bottle tank is then adjusted until the surface of the liquid within the upper gauge glass of the bottle is in the plane of the gauge mark. There may be some difficulty in making this adjustment due to the fact that the surface that of the liquid in the tank will be above the gauge mark by an amount sufficient to balance the pressure of the prover. By manipulation of the prover slide valve the zero of the prover scale is now brought exactly to the zero of the pointer. Now raise the bottle steadily from the tank, thus drawing into it air from the prover. Since the test is being made at the usual prover pressure the opening of the lower neck will still be submerged by an amount sufficient to equal the pressure of the prover when the bottle is filled with air. Therefore it will be necessary to raise the bottle very slowly when it is nearly filled with air and to stop the instant the first small bubble breaks out from the bottom of the bottle. If the work is done carefully there is no need of losing more than one or two very small bubbles of air at the most.

Now that a foot of air has been removed from the prover the valve between the prover and bottle is closed and the reading of the prover scale is noted. A small amount of air is then returned from the bottle to the prover so as to raise the 1-foot mark of the prover scale above the index mark and the remainder of the bottle full of air is discharged so as to again submerge the bottle. Now adjust the prover bell so the 1-foot mark coincides with the index mark and proceed to bottle out another foot of air.

This procedure may be subject to a slight error if water is used in the tank of the bottle and the air in the room is not saturated with water vapor. Under these conditions the bottle raises from the tank wet and the evaporation from the wet sides may cool the air within sufficiently to cause an appreciable error. This possibility of error may be greatly reduced by having the air in the room saturated with water vapor and by keeping the surface of the bottle well polished or oiled, and may be practically eliminated by using a light clear oil in the bottle tank.

If the test is made at atmospheric pressure the procedure will be substantially the same as that just described. The special precautions occasioned by the prover pressure will now be necessary. However, it would be advisable when raising the bottle from the tank not to completely unseal the bottom of the lower neck until after closing the valve between the prover and the bottle in order to guard against accidental shifting of the prover bell.

(b) Bottling Into the Prover. This method is the reverse of the preceding, with the exception that it is practically necessary to use atmospheric pressure in the bottle and prover during the test. This merely requires that the counterweights of the prover be increased until the bell is just balanced.

The same care must be taken to prevent temperature changes and errors due to moisture on the sides of the bottle which was mentioned in the preceding section.

5. In order to insure that a meter may operate accurately when placed in service it is necessary that such tests be made as will determine its accuracy at the average speed at which it will operate. At least three tests at widely different rates of flow are necessary to prove that a meter operates consistently throughout its entire range of capacity. Either as one of the three above mentioned rates or as an addition thereto it is necessary to determine if the meter will operate on a light consuming not more than one-quarter to one-half of 1 foot per hour. Few, if any, gas companies prove the accuracy of their meters at this rate. If a meter refuses to move or register at all at this low rate it will not measure gas accurately at higher rates of flow.

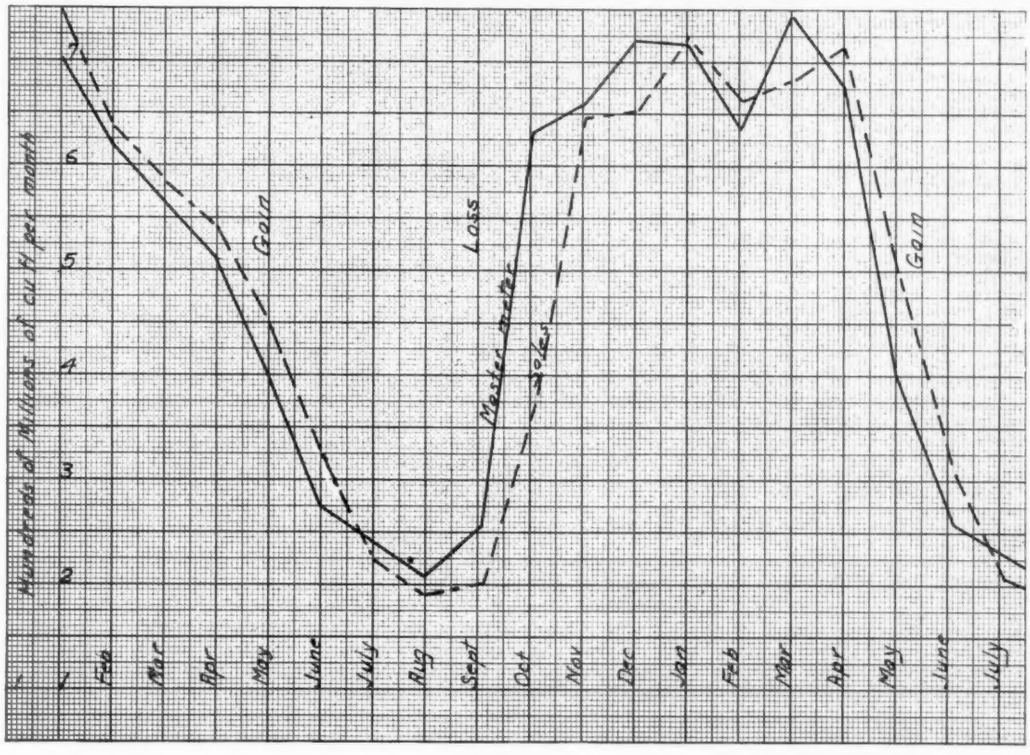


Figure 4

It has been proven that when a meter of the positive type such as used for domestic purposes or a similar one of large size is correct mechanically it will function very consistently throughout its range of capacity. On the other hand, a meter which is not in proper mechanical condition will produce very erratic results. A system has been developed for use in meter repair shops which presents the results of tests at three decidedly different rates in such a graphic manner that the condition of the meter, not only as to its accuracy but its mechanical condition as well is indicated. It also indicates whether or not there are leaks anywhere present, whether the diaphragms are tight, the valves properly fitted and the valve travel correct. The most satisfactory rates for these three tests are 10, 50 and 100 per cent of meter capacity at 1½ inches of water absorption pressure. It is possible in this manner to quite accurately determine the accuracy of a meter at any rate of flow within its rated capacity. A graph is made of the tests of each meter so tested. If the points on the graph representing the tests made at the three different rates falls on a straight line the workman knows that the meter is mechanically correct and proceeds with the adjustment for accuracy. If, however, the three points do not fall in a straight line, he knows that something is wrong, and the meter is returned to the bench for correction. With this information at hand it is readily apparent that from the graph the condition of the meter at any rate can be read opposite the rate. It is also apparent that since the three test results appear in a straight line that any tests at other rates would add other similar points on the same line. It is fair to assume that since any number of tests so plotted on a graph fall on a straight line when the meter is in proper condition that this line may be extended in either direction to obtain the accuracy of the meter in question at any other rate within its capacity. In this manner large positive meters may be tested by using smaller meters of a similar type whether in the field or shop and the tester relieved of the necessity of any calculating whatever. Tests are made by passing 100 feet or more of gas through the meters in series and the accuracy of the meter being tested is a direct comparison of the two meter registrations. If only 100 feet are passed the percentage of error is readable directly as a difference of amounts the same as when making a prover test.

Checking by Graphs

This graphic presentation of the tests constitutes the best possible check on the accuracy of the work of the repair man and it is believed by many to have done more toward the proper education of the workman than months of oral instructions could possibly do.

In repairing meters to operate within 1 per cent fast or slow at any rate from 1 foot per hour to maximum capacity a great deal of trouble may be expected in the proving room unless the work on the bench is very thoroughly done. It is usually found cheaper to rebuild rather than repair all cast iron meters. The diaphragms being removed for examination and reoiling after which the good ones are put in other meters but never mixed with new diaphragms. All old or new ones are used together in a meter, never old and new mixed.

The proper kind of oil for use in meter diaphragms has been the subject of considerable investigation during recent months. No very definite and universally acceptable answer has been obtained so far. A determined effort is being made, however, to determine the most satisfactory oil to use in meters measuring gas from which the gasoline vapors have been removed and which, for that reason, has a very active drying action on diaphragms oiled with oil soluble in gasoline.

Leakage in Distributing Systems

Testing. It is customary for many gas companies to maintain measuring stations at town borders to check the total amount of gas delivered into the town as a means of determining the "unaccounted for gas" as represented by the difference between the master and domestic meter measurements. This difference is usually attributed to leakage. However, the loss so determined is not necessarily leakage because it embraces any slight error in either measurement.

If due diligence is exercised in repairing all leakage which can be located by examining closely any surface indication the loss can usually be kept below 200,000 feet per mile of 3-inch pipe per year.

Where the continuous system of meter reading is used it is very difficult to get any idea of the amount of gas lost by comparing the monthly totals. It is only obtained by comparing yearly totals. The monthly totals if compared will show an unusually large amount of lost gas in the increasingly cooler months in the fall and a corresponding gain in the spring. A curve of such a comparison is shown in Figure 4.

The manner in which leakage varies with increased pressure depends on the nature of the opening in the walls of the pipe. We are told that when the leakage is seepage through long microscopic passages like where it follows a thread in a coupling or seeps through a sponge like rust scale wall of the pipe the volume of gas lost varies as the square of the pressure. When the hole in the wall of the pipe is clean and the flow unobstructed by the earth the leakage in a town plant varies somewhere between these two ratios. Therefore, since leakage varies as some direct function of pressure, it behooves all gas companies to keep the pressure in their lines as low as possible consistent with good service to the consumer.

Occurrence of Gas in Mid-Continent

Relative Positions of Oil and Gas Producing Horizons in Oklahoma, Kansas, North Texas and Panhandle Shown

By C. J. Peterson
Geologist, Empire Gas & Fuel Co.

This paper refers particularly to the geologic occurrence of gas in Kansas, Oklahoma and North Texas. The portion of North Texas described is the Red River portion and the Texas Panhandle. The Texas discussion is very brief as time has not been available to go into the detail the region deserves. For convenience, in this article, the small portion of Texas described, is referred to as North Texas. The map appended shows the limited Texas area involved. Kansas and Oklahoma are treated with more detail.

No originality is claimed for this article. This is merely a general summary of conditions. These matters have been described in great detail in the publications of the United States Geological Survey, the Geological Society of America, the American Association of Petroleum Geologists, the American Institute of Mining and Metallurgical Engineers, the United States Bureau of Mines and the State Geological Surveys of Kansas, Oklahoma and Texas. For this discussion, the publications referred to have been consulted and used freely. F. C. Campbell drafted the accompanying map and his assistance is much appreciated.

The geologic occurrence of gas cannot be separated from that of oil and gas, except that under certain geologic phenomena, gas is sometimes found without oil being present. The geological conditions responsible for the accumulation of oil and gas are generally identical, because when petroleum is in the making gas is probably evolved from oil.

The map appended shows the main producing oil and gas fields of Kansas, Oklahoma and a portion of North Texas and the regional geological conditions. (See page G-116). On page G-119 is a generalized stratigraphic column for Kansas and Oklahoma, not including the Comanchean and Cretaceous formations. The correlations are not claimed to be exact. The problems of the exact contacts between the Mississippian and Pennsylvanian series and the Pennsylvanian and Permian series and some of the sand correlations have not yet been solved. The object of the stratigraphic chart is to show approximately the relative positions of the oil and gas producing horizons.

History of Development

Dr. G. W. Brown began prospecting for oil in Miami County, Kansas, east of Paola in 1860, visiting tar springs on the Wea and asphalt deposits. Small gas wells were later discovered in Wyandotte County, Kansas. Small oil seeps in Shawnee County, Barber County and Cherokee County, Kansas, aroused interest at this time. Gas was first discovered at Iola in 1873. Considerable drilling was done in the Paola district between 1870 and 1890 and in 1882 gas wells were completed and gas was piped into Paola.

About 1890 a Mr. Mills began prospecting for oil in the vicinity of Neodesha. He interested the firm of Guffey and Gailey of Pittsburgh, and they piped gas into Neodesha on July 4th, 1894. They sold out to the Forest Oil Company which was finally incorporated as the Prairie Oil and Gas Company. This was the initiation of the now well known company of that name. The gas sand which has been so productive near Iola, was struck at a depth of 840 feet in December, 1893 or January, 1894. The greatest petroleum development began in 1900 and oil pools were opened up in both Kansas and Oklahoma. Allen, Neosho, Montgomery and Chautauqua Counties, Kansas, were very active.

The completion of gas pipe lines to Kansas City, Kans., Topeka, Lawrence and Leavenworth, Kans., and Joplin, Mo., in 1905, and to Atchison, Kans., Kansas City and St. Joseph, Mo., in 1906, stimulated search for gas. The Augusta Field was opened in 1914 and this began the Butler County, Kansas, development.

In Oklahoma, during 1904, the Bartlesville Field became developed extensively. The Glenn Pool was opened in 1906. In 1912, the immense Cushing Pool had its beginning and the Healdton Pool was opened in 1913. In 1915, several wells drilled in McIntosh, Haskell, Coal, Hughes and Latimer Counties, Oklahoma, found gas without oil.

The first commercial discovery of oil in North Texas was at Corsicana in 1895. In 1900 the Powell District was opened up. Oil was found at Petrolia and Electra in 1910. The Burkburnett Pool was opened in 1912, the immense Ranger Pool, the Duke Pool in Comanche County and opened up in Elk, Butler and Cowley Counties.

Gas pipelines were extended and now the natural gas industry has become one of the most important in Kansas, Oklahoma and Texas.

Topography

The range of elevations above sea level in the area here described is from 750 to 5,000 feet, the highest portion being on the high plains area of Texas and western Kansas. The main portion of Kansas and Oklahoma is fairly flat and represents a regional basin, bounded by the high plains of the Texas Panhandle and Colorado, on the west, the Ozark Mountains to the east and the Arbuckle and Wichita Mountains to the south. Oklahoma's southern boundary is the Red River, which flows to the east.

Regional Geologic Structure

The accompanying map shows the main regional geologic features in Kansas and Oklahoma. The strata have a regional dip west and northwest from the Ozark, Ouachita, Arbuckle and Wichita uplifts to the central portion of the area. These regional dips are rather flat and range from ten to fifty feet to the mile on the surface. Steeper dips occur in the vicinity of the uplifts. On the western borders of the area, strata dip to the east off of the arches and uplifts in New Mexico and Colorado. Thus the central portion of the area is synclinal and the oil and gas producing fields of Kansas and Oklahoma are in a structural basin. Drilling has disclosed in Kansas the presence of a buried granite mountain, the location of which is shown on the map herewith. This ridge probably extends south into Oklahoma, at depth. In southeastern Oklahoma is an immense fault known as the Choctaw Fault. Between the Ouachita uplift and the Choctaw fault is a highly folded, faulted and contorted area, too broken to look promising for production of petroleum. The regional dip in the main productive fields is flat. Local interruptions to this flat dip and resultant folds are the cause of accumulation of oil and gas in every case.

In the North Texas area, shown on the map, south of the Red River, strata dip toward this area from the Ouachita uplift on the north and also toward it from the Llano Burnett uplift which is to the south in Texas and not within the boundaries of the accompanying map. Local arches and folds control oil and gas accumulation.

In the Panhandle area, two large domes are evident on the surface in Potter and Carson Counties. The main regional structural feature, as revealed by drilling, is a buried granite ridge. Sediments compacted on this ridge have formed a trap or dome which has accumulated oil in places, and an immense amount of gas. This granite ridge is apparently an extension of the Wichita Mountains uplift.

Stratigraphy

General stratigraphic sections of Kansas and Oklahoma are shown on Page G-119. The Comanchean and Cretaceous formations, which overlie the Permian, are not shown, because, to date, the Cretaceous and Comanchean have been unproductive of oil and gas in Kansas and Oklahoma. The outcrops of the Pre-Cambrian, Cambrian, Ordovician, Silurian and Devonian formations occur only near the uplifts. The contacts of the Mississippian, Pennsylvanian and Permian formational divisions are shown on the accompanying map.

Tar springs and asphalt deposits have been found at the outcrops of Ordovician, Silurian, Devonian, Mississippian, Pennsylvanian and Cretaceous formations on the borders of the uplifts shown on the map, at approximately the horizons which are productive of oil and gas underground. The Cretaceous formations have not produced oil or gas to date in commercial quantities in Kansas and Oklahoma.

In Kansas and Oklahoma there are productive horizons in the Siluro-Devonian, Ordovician and Mississippian but the greatest number occur in the Pennsylvanian and particularly in the Cherokee shale division of the Pennsylvanian.

The formations shown on the stratigraphic column are sedimentary with the exception of granite. These formations were deposited in the seas which represented the time eras of their deposition. Due to erosional periods between deposition periods, unconformities occurred between the major divisions, which are shown on the chart.

As deposition takes place in seas and sediments are washed into them, sand and shale deposits generally occur near shore while lime deposits generally occur in deeper water. The Kansas Pennsylvanian section contains much more limestone than the Oklahoma Pennsylvanian section. This means that the Kansas area was in deeper water than the Oklahoma area at the time of the Pennsylvanian sea and the Oklahoma Pennsylvanian was deposited nearer shore, the sediments in southeastern Oklahoma probably coming from the Ouachita and Arbuckle land masses in Pennsylvania time. Due to this condition the Cherokee shale section is very thick in the southeastern part of Oklahoma and thins out going north. Part of this extraordinary thickness in southeastern Oklahoma, may be due to overlap. In Coal and Pittsburg Counties, Oklahoma, Taff correlated the Atoka, Hartshorne, McAlester, Savanna and Boggy, a thickness of 9,000 feet, with the Cherokee shale. Futher north, near Muskogee, the Winslow and Boggy formations with a thickness of 1,500 feet were correlated by Taff with the Cherokee formation, while in Kansas the Cherokee shales have decreased to a thickness of 425 feet.

On the map is shown the location in Kansas of a buried granite ridge, as disclosed by drill holes. In places, Pennsylvanian formations rest directly on the granite, but have not been metamor-

If You Doubt West Virginia Hills Are Steep, Just Ask John Corrin

West Virginia is known throughout the oil and gas fraternity as one of the most mountainous areas in the country to drill for oil or gas. The sides of some of the mountains and hills are almost perpendicular. Yet the natives in these sections raise good crops of corn and other farm products and they have become quite adept in farming on the terrace plan. However, it must have been a newcomer John Corrin met one day on one of his periodical inspection trips over properties of the Hope Natural and other companies he manages.

Mr. Corrin and others of his company were driving along the side of a steep hill when they discovered a man sprawling on the road. Quickly stopping their car, they ran to the man and helped him to his feet.

"Were you hit by an automobile?," Mr. Corrin asked.

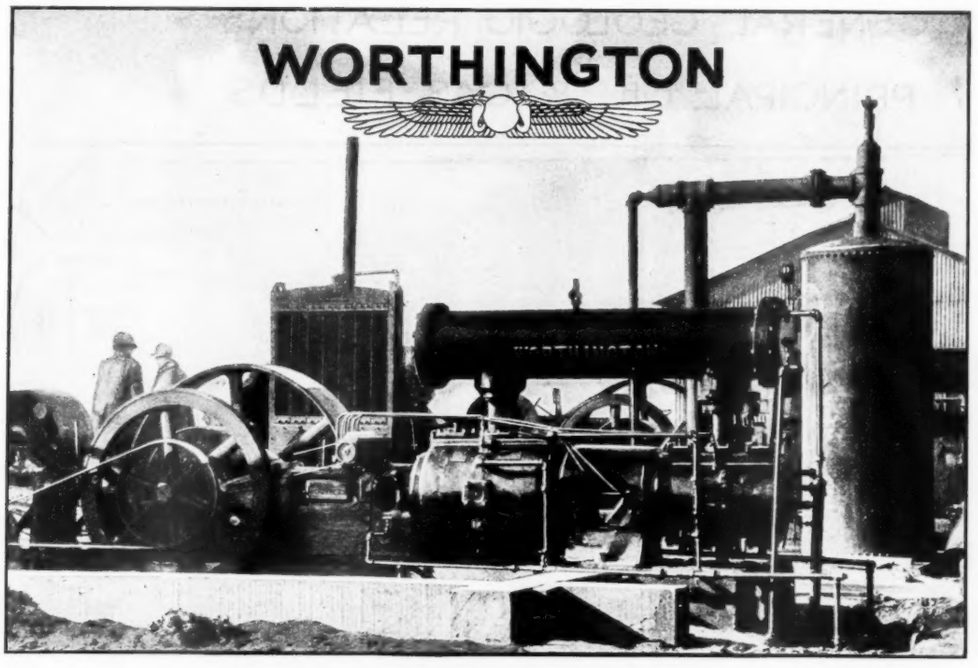
"Hell, no," answered the farmer. "There has not been an automobile along this road today. But this is the third time this morning I have fallen out of that darned corn field."

the new Burkburnett Pool in Wichita County in 1918.

Oil was then, as now, in these states the main object of exploration, and the production of gas, incidental. In 1907 the large Hogshooter gas pool was developed in Oklahoma. The Cushing Pool produced an immense quantity of gas. It is estimated that in this pool alone, 250,000,000,000 cubic feet of gas was wasted. There was a large amount of gas in the Glenn Pool. In northern Oklahoma large quantities of gas were developed in Osage County, in the Blackwell Pool in 1914 and other pools in Kay County. In southern Oklahoma, the Duncan Pool in 1912, the Healdton and Loco Pools in 1913, the Walters, Fox and Graham Pools in 1917, the Comanche Pool in 1919, and the Chickasha Gas Field in 1922, opened up large reserves of gas.

In North Texas, the Nocona Field in Montague County, the Petrolia Field in Clay County, the Electra Field in Wichita County, the Mineral Wells Field, the Ranger Field, the Mexia and Wortham Fields and finally the Panhandle Field, all opened up supplies of gas.

Development proceeded in southeastern Kansas and additional gas fields were



Two-stage, high-pressure FEATHER Valve Air Compressor, size 10 in. x 4¾ in. x 12 in., installed at Skelly Oil Company, Johnson Lease, near Borger, Texas.

Air-Gas Oil Pumping

PUMPS
-:-
COMPRESSORS
-:-
CONDENSERS
and
AUXILIARIES
-:-
OIL *and* GAS ENGINES
-:-
FEEDWATER HEATERS
-:-
WATER *and* OIL
METERS

This compressor has been designed especially for the oil fields and is suitable for either permanent or semi-permanent installations. Mounted upon skids, it is easily transported from one location to another with a minimum of trouble and without injury to the machine.

It can be driven by electric motors, gas or oil engines and is adapted to belt drive, short coupled or otherwise.

A complete line of Worthington FEATHER Valve Compressors has been developed to meet all conditions in the oil-field and the most commonly used sizes are available for immediate delivery from Tulsa stock.

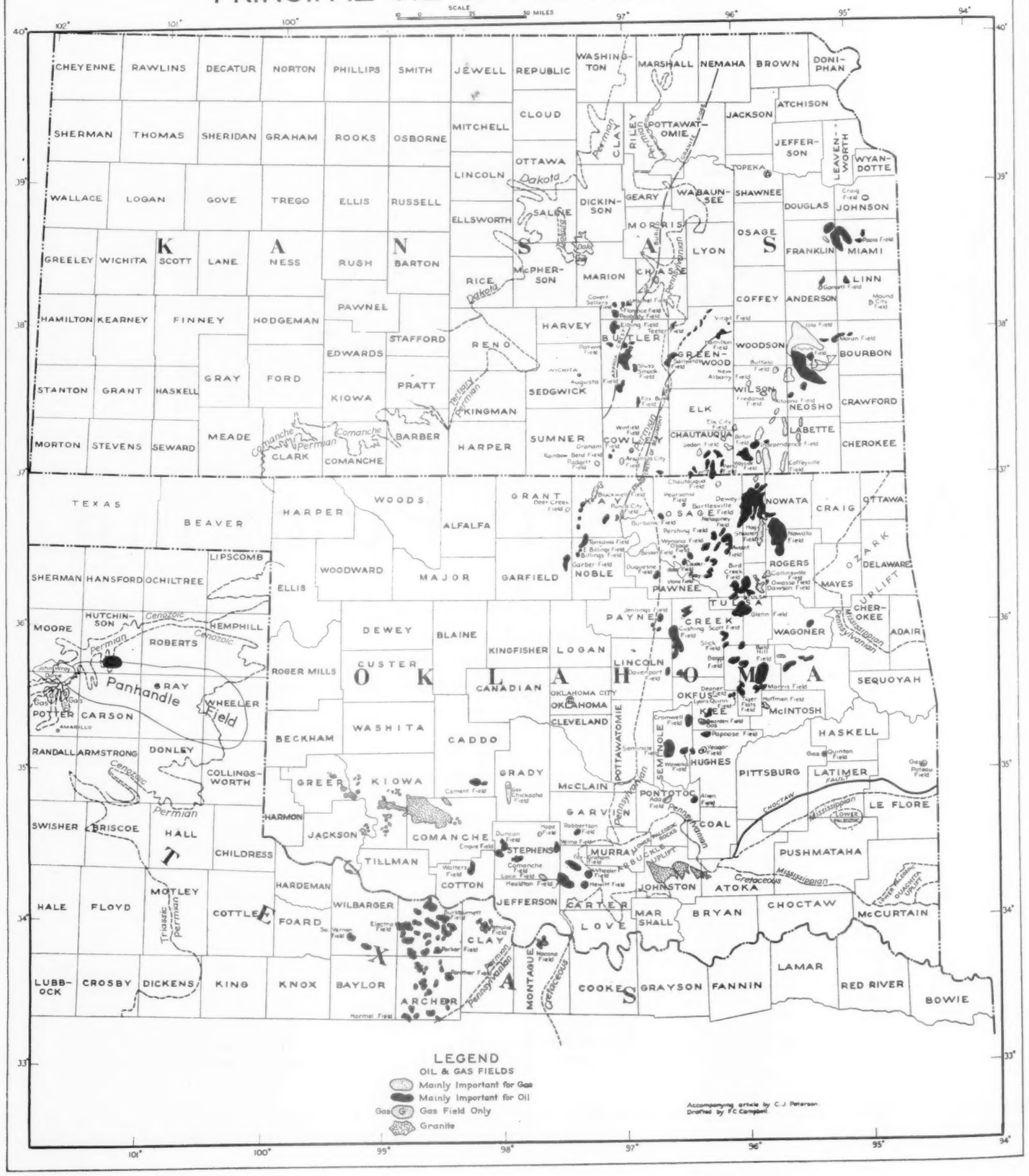
Oil Field Specialists at

Tulsa, Okla.	Worthington Machinery Corporation of Okla.
Borger, Texas	Western Supply Company
Houston, Texas	A. M. Lockett & Company, Ltd.
Dallas, Texas	A. M. Lockett & Company, Ltd.
New Orleans, La.	A. M. Lockett & Company, Ltd.
Los Angeles, Cal.	Worthington Company, Incorporated

6735-5

WORTHINGTON PUMP and MACHINERY CORPORATION, 115 Broadway, New York, U. S. A.

GENERAL GEOLOGIC RELATIONS OF PRINCIPAL OIL & GAS FIELDS



Leschen Wire Lines
Have Stood the Service Test

Results are what count, and Leschen Wire Lines have a long service record to their credit. They have actually proved their exceptional ability to stand the wear and tear of oil and gas field work.

The uniformly high quality of Leschen Lines is due to our rigid wire tests. These tests plus our methods of manufacture insure the necessary strength, elasticity and wearing qualities.

We are sole makers of these well known lines:

Patent Flattened Strand
***"Hercules" [Red-Strand] Rotary Cable**

The famous "California Special" Drilling Cable
for Cable Tool Drilling

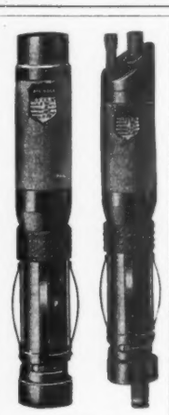
***"Hercules" [Red-Strand] Casing Lines**

Established 1857

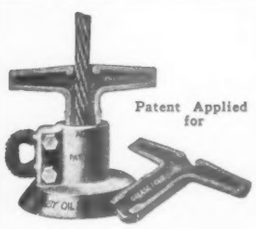
A. Leschen & Sons Rope Company
ST. LOUIS

General Distributors—**OIL WELL SUPPLY CO.**—Pittsburgh, Pa.

*Reg. U. S. Pat. Off.



Hook Wall Packers



Patent Applied for

Common Style Larkin-Rigby Oil Saver, Showing Steel Hollow Top Grease Cup.

Automatic Style Larkin-Rigby Oil Saver

Patented 1914

California Style Larkin-Rigby Oil Saver

Drilling Bit Jars

Combination Anchor and Wall Packer—Conical Sleeve.

Larkin 3-in-1 Gas Anchor Packer

LARKIN'S IMPROVED SAND PUMP

The Larkin Line

Patent Hook Wall Packer—strongest, safest and most simple self-supporting wall packer on the market;

Special Gas Anchor Packers—with adequate protection of rubber for lowering in well under pressure;

Special Packers—for all types of special services;

Improved Sand Pump—20 feet long, flush outside, of uniform, Cold-Drawn "NATIONAL" Seamless Steel Tubing, equipped with Regular or Bit Bottom.

Never-Slip Pipe Grips—least expensive, swiftest and simplest device made for putting in casing.

Larkin-Rigby Oil Saver—the positive acting automatic latching and unlatching action, plus other exclusive advantages, makes this a time, trouble and expense saver as well as an oil saver.

The Larkin Service

Large stocks are carried which are always available for prompt shipment.

The Larkin stock rooms contain all types of packers known to the trade.

Packers will be built especially to suit your particular requirements.

Complete line of Drilling and Fishing Tools for sale and for rent.

Buy The Larkin Line at any of the leading supply stores.

Larkin & Co.

Butler — Pennsylvania — U. S. A.

Our Bulletin No. 30 describes *The Larkin Line* Write for it.

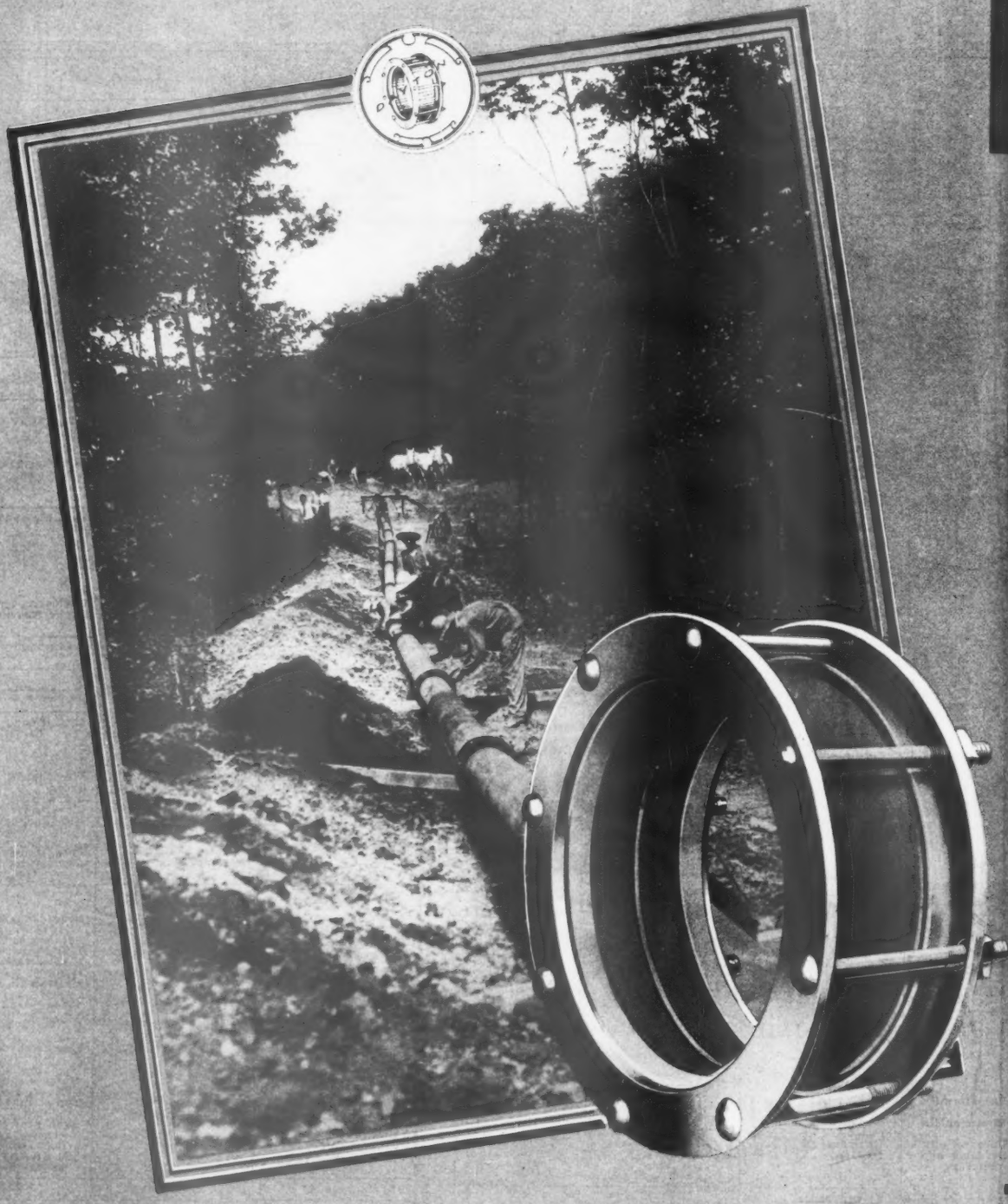
GENERALIZED STRATIGRAPHIC COLUMN FOR KANSAS AND OKLAHOMA

Not including Comanchean and Cretaceous Series

(Correlations are not claimed to be exact. The object of the chart is to show approximately the relative positions of the oil and gas-producing horizons)

	KANSAS			OKLAHOMA			
Series	Formation	Member	Producing Horizon	Formation	Member	Producing Horizon	Correlated With
Quaternary							
Unconformity							
Tertiary							
Unconformity							
Permian	Greer	Big Basin sandstone Hackberry shale		Greer			
	Woodward	Day Creek dolomite Whitehorse sandstone Dog Creek shale		Woodward	Day Creek dolomite Whitehorse sandstone Dog Creek shale		
	Cave Creek	Shimer gypsum Jenkins shale Med. Lodge gypsum		Blaine	Shimer gypsum Jenkins shale Med. Lodge gypsum		
	Enid	Flower Pot shale Cedar Hills sandstone Salt Plain shale Harper sandstone		Enid			
	Wellington			Wellington			
	Marion	Abilene conglomerate Pearl shale Herington limestone Enterprise shale Luta limestone		Chase	Herington limestone Uncas shale		
	Chase	Winfield limestone Doyle shale Fort Riley limestone Florence flint Matfield shale Wreford limestone		Blackwell	Winfield limestone Doyle shale Fort Riley limestone Matfield shale Wreford limestone		
	Council Grove	Garrison limestone and shale Cottonwood limestone		Blackwell	Crouse limestone Cottonwood limestone		
Base of Permian?							
	Wabaunsee	Eskridge shale Neva limestone Elmdale shale Americus limestone Admire shale Emporia limestone Willard shale Burlingame limestone			Neva limestone Red Eagle limestone Foraker limestone	800 feet gas sand at Tonkawa 1,400 feet gas sand at Tonkawa	
Base of Permian? Pennsylvanian							
	Shawnee	Scranton shale Howard limestone Severy shale Topeka limestone Calhoun shale Deer Creek limestone Tecumseh shale Lecompton limestone Kanwaka shale	Elgin sands		Pawhuska limestone	Newkirk sand (gas) Upper Hoover Lower Hoover	1,400 feet gas at Blackwell; 2,000 feet gas at Deer Creek 2,400 feet gas at Deer Creek
	Douglas			Elgin sands			
	Lansing			Buxton		Ponca sand	Tonkawa sand and Stalnaker
	Kansas City		Gas sands Stray sands	Wilson Ramona			
	Marmaton	La Cyne shale Lenapah limestone Nowata shale Altamont limestone Bandera shale Pawnee limestone Labette shale Fort Scott limestone	Old Red sand Peru sand Oswego sand	Curl	Lenapah limestone Nowata shale Oolagah Labette shale Fort Scott	Layton sand Wayside Jones McEwen Cleveland Big lime Peru sand Oswego lime	Layton sand Wheeler, Swenson and Claremore
	Cherokee shale		Undifferentiated sands Bartlesville sand Burgess sand	Cherokee shale		Prue sand Skinner sand Red Fork sand Nemire sand Sand Bartlesville sand Tucker sand Deaner sand Burgess sand	Squirrel, Bixler and Perryman Glenn, gas of Morris, salt and Burbank Booch, Squaw, Meadows, Taneha, Dutcher (called Burgess in places) Glenn of Morris, Glenn, Greasse, Youngstown, Preston, Rhodes Sand on top lime
Unconformity							
Mississippian	Boone limestone		"Chat" horizon	Mississippi Lime	Pitkin	Top of lime	
Unconformity Devonian and Silurian	Chattanooga Hunton		Misener sand	Chattanooga Hunton	Caney	Lyon sand? Misener sand Wilcox sand at Mounds and Sapulpa under Chattanooga*	Cromwell, Papoose
	Sylvan shale			Sylvan shale			
	Viola limestone			Viola limestone			
Unconformity Ordovician	Simpson	Wilcox sand Tyner formation Burgen sandstone	Wilcox sand	Simpson	Post Wilcox* Wilcox sand Tyner formation Burgen sandstone Lower Simpson:	Hominy "Wilcox"	At Okemah, Wewoka, Cromwell and Seminole
Unconformity Ordovician and Cambrian	Arbuckle limestone		Siliceous lime	Arbuckle limestone		Siliceous lime	Turkey Mountain
Cabrian	Reagan sandstone			Reagan sandstone			
Unconformity Pre-Cambrian	Granite			Granite			

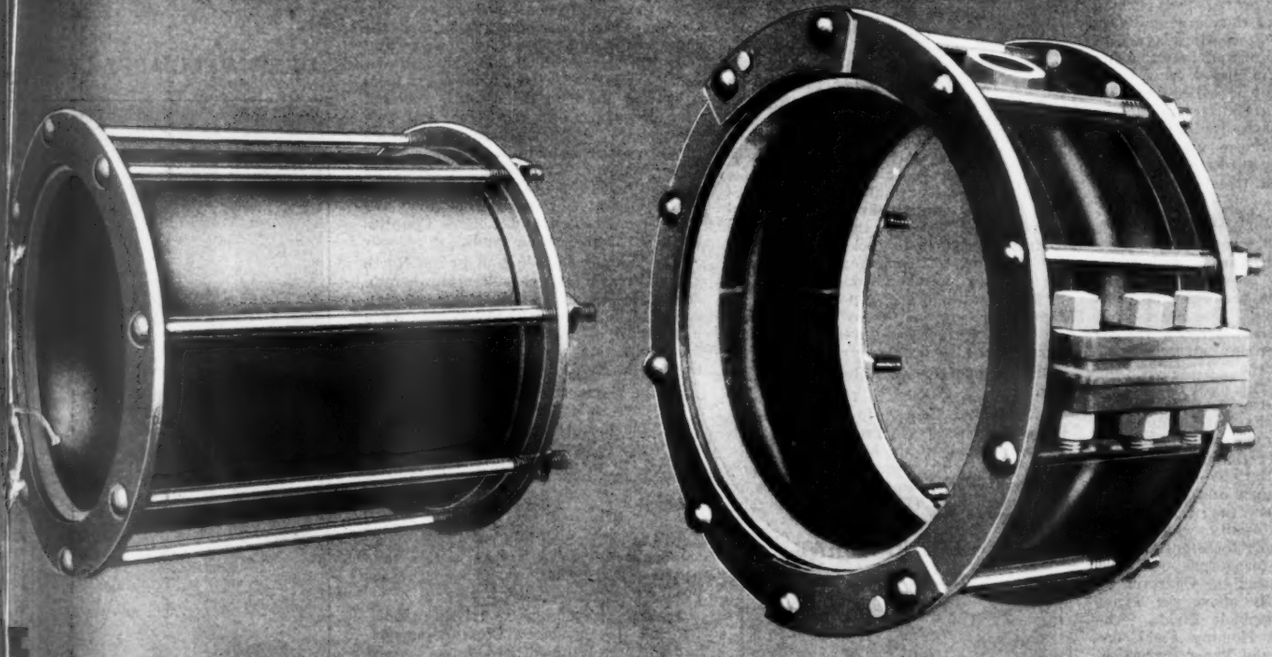
*After Luther H. White: Subsurface Distribution and Correlation of the Pre-Chattanooga ("Wilcox" sand) Series of Northeastern Oklahoma. Oklahoma Geological Survey. Bull. No. 40-B.



THE
NATIONAL
COMPANIES

AYTON

OUPLINGS
SLEEVES
CLAMPS



THE
AL SUPPLY
IPANIES

phosed. Thus this granite was not intrusive and must have been submerged in the Pennsylvanian sea. Mississippian formations have also been found resting on this granite, so this ridge has been subject to elevation and erosion between Mississippian time and Pennsylvanian time.

Mississippian

Some consider the Cottonwood limestone as at the base of the Permian series, while others place the base of the Permian at the base of the Elmdale shale It is not at all certain just where the contact between the Pennsylvanian and Mississippian is, especially in southeastern Oklahoma. The writer is not certain as to whether or not the Lyons sand is Mississippian or Pennsylvanian. It looks as though it is probably Mississippian. Luther H. White, Frank C. Greene,, F. L. Aurin, G. C. Clark and E. A. Trager have done valuable work in straightening out the Pennsylvanian, Mississippian, Ordovician problem.

In the portion of Texas which includes Montague, Clay, Archer, Wichita and Wilbarger Counties, the surface formations are Cretaceous, Pennsylvanian and Permian and their contacts are shown on the accompanying map. The Permian section comprises from 400 to 1,500 feet of red beds which lie unconformably on the Pennsylvanian, the upper member of which is the Franks conglomerate, which in turn lies unconformably on top the Glenn formation. The main production of oil occurs in the Pennsylvanian although some gas occurs in the Permian formations. Apparently the source of the sediments here was in the Wichita, Arbuckle and Ouachita uplifts.

In the Panhandle, Texas area of Potter, Moore, Hutchinson, Carson, Gray and Wheeler Counties that strata encountered on the surface are recent windblown sands, river alluvium, caliche and Triassic sandstones. Below these lie the Permian quartermaster formation with the Alibates dolomite at the top. Below the Alibates dolomite the red beds extend about 1,300 feet and then are underlain by red beds with alternating layers of gypsum and anhydrite and limestone up to 2,200 feet depth in places. This series is underlain by what is called the "big lime" which is about 800 feet thick. The big lime is underlain by shale and under the shale occurs arkosic granite wash which ranges from 3 feet to 250 feet in thickness. Under this is the granite ridge.

Nomenclature of Horizons

Referring to the generalized stratigraphic column for Kansas and Oklahoma, there is some inconsistency in the use of names of the producing horizons in different localities. The Peru sand in its type locality occurs below the big lime. Drillers sometimes call a sand occurring between the Altamont and Pawnee limestones, the Peru sand. The Burgess sand is used by some for a sand occurring between the Bartlesville sand and the Mississippian lime. Others call a sand occurring directly on top the Mississippi lime, the Burgess sand. The Wilcox sand at Mounds and Sapulpa occurs directly under the Chattanooga shale, due to unconformity, while it has the Post Wilcox, Viola limestone, Sylvan shale and Hunton formations occurring above it between it and the Chattanooga shale, and is directly above the Tyner formation in the Seminole Field. The Wilcox sand of the Hominy Field, lies directly underneath the Tyner formation.

Types of Accumulation

The most lucrative oil and gas fields in the area under discussion have occurred on domes with closure in the producing horizons. These have been of two types: 1. True Folds, such as the Cushing Dome, Hominy Dome and domes in the Osage Reservation. 2. Domes formed by the compacting of sediments on the tops of buried mountains, such as the Healdton Dome and the Chickasha Dome. In these closed folds the gas occurs in a higher structural position than the oil. In some cases sand conditions have played a big role in the distribution of accumulation, by causing sealing of sands by contact with impervious shales and by variations in porosity and tightening of the sands in places.

Some accumulation has occurred in lenticular sands sealed by impervious shales. The so-called "Shoe String" sands of Montgomery, Allen and Wilson Counties, Kansas, are a peculiar form of this type of accumulation.

Variations of porosity in sands are sometimes responsible for accumulation, or rather, position of accumulation. In Elk County, Kansas, some of the accumulation seems to be off the tops of folds and on the flanks. This is probably caused by a tightening of the sands on top of the folds.

There is quite an area near Neodesha, Kans., where small open flow, low rock pressure gas wells occur in the black shale 20 feet below the top of the Oswego lime. These are long lived and have considerable water with the gas. It is possible that this gas is sealed in the shale and water breaks the shale down and lets the gas escape. The capacity of the wells is generally less than 30,000 cubic feet.

Some oil and gas occurs on terraces, but generally in these cases, subsurface study shows closed folding in the producing sands, or lenticular sand conditions.

Relation of Folding

The relation of subsurface to surface folding varies greatly in different localities. In portions of Greenwood County, the shallower producing sands seem to follow the surface structure fairly well while there seems to be a shift in the folding in the deeper sands Trend production here is generally better on the surface highs than in other places, when a trend crosses a structure. In the El Dorado Pool, Kansas, the sub-surface folding agreed well with the surface highs. In the Osage and in the Cushing Pool area, the subsurface highs agreed well with the surface highs. In all cases, however, the subsurface dips on the flanks of the folds were steeper than the surface dips. In Hughes, Okfuskee and eastern Creek Counties, surface warping seems to reflect subsurface folding, but the location of the subsurface highs has to be proved with the drill, as they do not coincide with surface highs. Faulting in the surface rocks of Creek, Lincoln and Seminole Counties seems to reflect deep-seated folding although the surface faulting does not locate the structural highs on the subsurface folds. It seems as though deep seated folds in competent rocks have affected the overlying less competent rocks, causing faulting in the surface rocks, although faulting has not occurred at depth. In many of the red bed Permian areas, the surface exposures are so poor, that surface work is not reliable.

Productive Gas Horizons

In eastern Kansas, in fields extending from Johnson County to the Oklahoma line, the greatest gas production has occurred in sands at the base of the Cherokee shales, with some scattered production in the Mississippi Lime. Sands in the Admire shale (Upper Pennsylvanian) have been good producers of gas in Butler and Cowley Counties and have produced a little gas in Chase County. The Kansas City formation sands have furnished a great deal of gas in Greenwood, Elk and Cowley Counties and have produced a little gas in Chase County.

In Oklahoma, most of the oil-bearing sands have produced gas in the different fields. Most of the gas production in the fields of Washington, Tulsa and Rogers Counties has occurred in the Burgess and Tucker sands and some in the Bartlesville sand. In Osage County, gas production has occurred in the Cleveland, Peru, Oswego, Prue, Bartlesville, Tucker, Burgess and Mississippi lime sands. In Creek, Lincoln, Payne and Pawnee Counties, the main gas production has been in the Layton, Prue, C'eveland, Wheeler, Skinner, Bartlesville and Tucker sands. In Noble, Kay and Grant Counties, shallow Permian sands have produced some gas, but the main gas production has occurred in the following sands which occur in the Upper Pennsylvania formations: 1,400 gas sand at Tonkawa, Newkirk, Tonkawa, Hotson, lower Hoover and Layton sands. In Okfuskee, Hughes and Okmulgee Counties the principal commercial gas has occurred in the Glenn, Booch, Dutcher, Gilcrease and Lyons sands. In Caddo, Carter, Comanche, Cotton, Grady, Jefferson and Stephens Counties shallow Permian sands produce some gas but the most important gas production is in a series of upper Pennsylvanian sands. It is possible that these gas horizons are very close to the stratigraphic position of the sands producing gas in the Tonkawa, Ponca City, Deer Creek and Billings Fields and vicinity. The important gas-producing horizons of the Chickasha Field are the Nichols and Ramsey zones, and another horizon, not so important, called the Magnolia sand. The Fox Field gas horizons comprise a shallow Permian gas sand, a stray upper Pennsylvanian gas sand, and oil and gas horizons known as the first and second zones, which occur at greater depth than those first mentioned above. The Graham Field produces gas from the Patsy gas sand, Kirk gas horizon and four other sands which carry both oil and gas. The Hewitt Field produces gas from a shallow Permian gas sand, a 600 foot deep Pennsylvanian gas sand and two other deeper Pennsylvanian sands which produce both gas and oil. The Healdton, Loco, Duncan, Walters and Wheeler oil and gas fields produce their gas from similarly located horizons. Gas in Coal, Pittsburg, Haskell and Leflore Counties occurs in Pennsylvania sands.

The main gas production in the North Texas area under consideration herein, occurs in sands of the Pennsylvanian series. The Petrolia Field has been quite a producer of helium gas and was a big factor in this type of gas production during the World War.

In the Texas Panhandle area the main gas occurs in a porous part of the "big lime," which is thought to be of Permian Age and also in a zone of arkosic granitic wash. Oil is also produced from these same horizons, at a lower structural position.

Principal Gas Fields

In the area of oil and gas fields which this paper describes, those which have been most important on account of gas production are the following:

In Kansas, the Paola, Iola, Fredonia, Altoona, Independence, Chautauqua, Arkansas City, Winfield, El Dorado, Augusta and Elk County Fields.

In Oklahoma, portions of Osage County, Hogshooter, Ponca City, Blackwell, Deer Creek, Tonkawa, Cushing, Glenn, Morris, Duncan, Wheeler, Hewitt, Healdton, Loco, Bearden and Chickasha Fields, besides many scattered fields.

In the Texas area described herein, fields with important gas production are the Nocona, Petrolia and Texas Panhandle fields besides other scattered fields.

Fields Which Produce Gas Only

Of the fields discussed, all produce both oil and gas except the Chickasha Field and the fields in Coal, Pittsburg, Haskell and Latimer Counties and vicinity, which produce gas only and do not produce oil.

In this area in Coal, Pittsburg, Haskell and Latimer Counties and vicinity north of the Choctaw fault, the formations are rather highly folded. Development, to date, in this area has produced gas only. The folds are sharp and this seems to be an area of gas production without oil. According to Gardner[1] this is due to metamorphism. Gardner gives as evidence, carbon ratios of coals of this belt, whose carbon ratios are high as 70 per cent. As stated by David White[2] and Fuller[3], the amount of metamorphism sufficient to change coals so that their carbon ratio equals 65 per cent or more, is probably sufficient to convert oil to gas. This metamorphism is probably caused by deformation and folding as coals show this metamorphic effect in areas of deformation. If the metamorphism and corresponding deformation which is its cause, is carried too far, neither oil nor gas occur. Later studies made by Croneis[4] place the carbon ratio percentage indicative of a degree of metamorphism severe enough to prevent gas occurrence, at higher limits than those mentioned above.

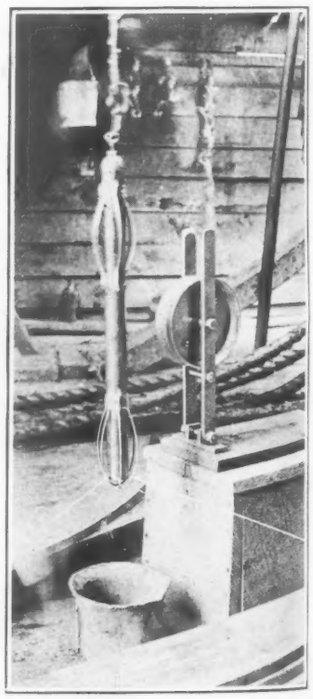
The Chickasha fold is known to have the steepest dips of any producing fold in the Mid-Continent Fields. It strata have been subject to intense deformation. Metamorphism, due to this intense folding, may be the reason why the Chickasha fold produces gas only and no oil.

[1]Gardner, J. H.: The Mid-Continent Oil Fields. Geol. Soc. America, Bull. vol. 29p. 699. 1916.
[2]White, David: Some Relations in Origin between Coal and Petroleum. Washington Acd. Sci. Jour., vol. 5, pp. 189-212, 1915.
[3]Fuller, M. L.: Appalachian Oil Fields. Geol. Soc. America, Bull. vol. 28, p. 6[illegible] 1917.
[4]Croneis, Carey: Oil & Gas Possibilities in the Arkansas Ozarks. American Assoc. of Pet. Geologists. Bull. vol. 11, pp. 279-297, 1927.

WELDING A LINE

The line is sloping downward towards the bed of the Little Kanawha River and preparations are being made to cross that stream.

DEEP WELL APPARATUS



Deep drilling for natural gas necessitated new apparatus. Shown above is a device (left) for taking temperatures in the well and on the right is shown a device for measuring the depth of the well.

Distribution of High Pressure Illuminating Gas

This old-style map shows the trunk lines of the Western United Gas and Electric Co.

Three 30"-stroke Ingersoll-Rand Compressors pump the gas from the plant of the Coal Products Co., Joliet, Illinois. They discharge at 50 to 80 lbs., and send out about 8,100,000 cu. ft. per day.

Elgin is 45 miles from Joliet. From Elgin the gas is pumped as far as Harvard, an additional distance of forty miles and a total distance of eighty-five miles from Joliet.

More information about high-pressure distribution systems and the Compressors which back them will be cheerfully furnished by any of the Company offices. These are located in important cities the world over.

INGERSOLL-RAND COMPANY

11 Broadway New York City

Offices in principal cities the world over.

872-C

Ingersoll-Rand

Oklahoma Contracting Company
Weldaline Company

Home Office:
513 Thomas Bldg.
DALLAS, TEXAS
Telephones 7-3296 and 7-3297

Branch Office:
509 Kennedy Bldg.
TULSA, OKLAHOMA
Telephone 6591

Pipe Line Contractors

T. R. JONES,
President

H. A. GUMP,
Sec'y & Treas.

C. J. MURRAY
Manager of Welding Company

Estimation of Natural Gas Reserves

Accurate Knowledge of Quantity of Recoverable Gas Available of Great Value to Operators and Public

By Ralph E. Davis
Consulting Engineer, Pittsburgh, Pa.

The great value of natural gas as a source of heat and light is recognized in localities which are served by this clean and economical fuel. Its production and utilization are important in some 17 of our states where approximately one-eighth of the total population of this country enjoy the benefits of this well-nigh perfect fuel.

It is a matter of vast importance to the people using natural gas, as also to those who produce and market it, that there be knowledge of the gas reserves available in the various fields from which their supply is drawn. The more dependable this knowledge, the greater is its value.

During the last few years, there has been a notable increase in the attention given this subject by executives of our larger natural gas companies. It has been natural that, during the period of prolific production in the older gas fields, attention should have been focused on the problem of finding markets competent to absorb large quantities of gas. With decline in production, the problem reverses itself, that is, attention tends to focus on the problem of maintaining a competent supply for the market already developed. In certain instances, it has been found necessary to augment the supply of natural gas, particularly in the period of peak demand in winter, with artificial gas. Under this situation it is evident that a knowledge of natural gas reserves, and their availability, becomes a matter of prime importance.

Many Factors Involved

Operators are finding that a knowledge of recoverable gas reserves is of importance also from the standpoint of field development. The spacing of wells is fundamentally related to quantity of ultimate production, as well as to rate of production, depth of wells, value of gas, etc. The size of new transmission lines should take account of the expected gas available.

The accounting department of a gas company finds it desirable in depletion and amortization problems to have knowledge of gas reserves. Without such knowledge the depletion and amortization charges are largely matters of personal judgment.

Now let us look into this matter of estimating gas reserves to see if it really be the mysterious sort of undertaking that some of our friends have thought. I hope to show that inasmuch as we have definite knowledge of the physical properties of natural gas, as also of the geologic factors which control its accumulation, it is possible by means of engineering methods to make sound estimates of natural gas reserves.

Nature of Gas Accumulation

Natural gas and petroleum are closely allied. They are similar in chemical composition, have a common origin and occur under related geological conditions. They are found in reservoirs beneath the surface of the earth where the accumulation is sufficient to warrant their extraction. In general, they are intimately associated with water. In such cases, the heavier liquid is at the bottom which results in the following sequence; gas at the top, oil next, with water below.

Near the surface, ground-water occupies pores and fissures up to different levels due to differences in the amount of rainfall and to variations in the topography and in the character of the rocks. The differences in level bring about movement of water from one point to another from which springs and artesian wells may result. In the deeper strata, migration is less rapid than at the surface but nevertheless important. Liquids found in sands at a depth of 2,000 feet are under pressure which may reach approximately 900 pounds per square inch. This pressure or hydrostatic head is due to the weight of liquid above and in oil field terms is known as the "rock pressure."

The fact that gas issues from a well when the pay sand is encountered does not mean that the gas occupies a great open space or cavern beneath the surface of the earth or that it comes from some deep, mysterious, generating mechanism, but rather that it is compressed into the minute spaces between the sand or other mineral grains, or is dissolved under pressure in oil with which it may be associated. The escape of gas to the surface through a well is evidence that pressure exists which, if released, allows the gas to expand or cause it to flow.

The amount of gas in any reservoir at the date the pool is tapped is definite in quantity except for the fact that gas is migratory in character and may move from one place to another or from points of high pressure to those of lower pressure. The number of tons of coal or of copper which can be removed from their containing rocks is limited to the amount actually present when the mineral body is found; likewise the amount of gas which can be removed from a container is virtually restricted to that present at date of discovery.

Reservoir Characteristics

Once the total original supply has been exhausted, no more can be taken from that particular source, and a new supply must be sought. The search for and discovery of new gas fields, their utilization, gradual exhaustion and final abandonment is the normal cycle of the natural gas industry.

In general, the reservoirs which contain gas or oil have certain characteristics which may be briefly outlined as follows:

(1) An upper, relatively impervious layer, commonly shale, lying at some depth below the surface.

(2) An underlying layer of porous rock such as sandstone or limestone.

(3) The above rocks folded in such a way as to form an inverted basin or reservoir from which the gas cannot escape.

These three conditions are illustrated in Figure No. 2 where "C" is the impervious bed, lying above "B" the porous bed, both of which, together with their accompanying strata, are folded into the form of an inverted basin. One of the common forms of such a dome or inverted basin is indicated by the contour map shown in Figure No. 1, which shows the depth of the producing sand "B" below an assumed datum-plane. Figure No. 2 illustrates a cross-section through this dome along the line A-A and shows how these beds would appear along the walls of a deep cut. Many other known types of structure may contain gas or oil or both but the one shown or some modification of it is common. It will be noted in the sketch that gas and oil cannot escape from the reservoir until an opening is made in it such as would be formed by the drilling of a well at either point 1 or 2. In most instances, the zone directly beneath the gas and oil is occupied by fresh or salt water and a well drilled at point 4 producing water would be called a "dry hole."

Conditions analogous to folding may also be produced in nature by variations in the character of the beds over considerable areas and by means of unconformities.

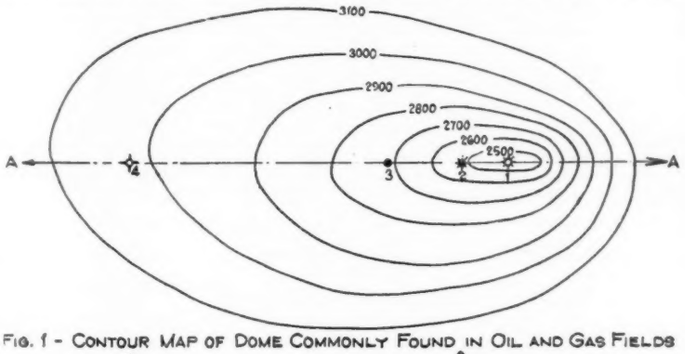
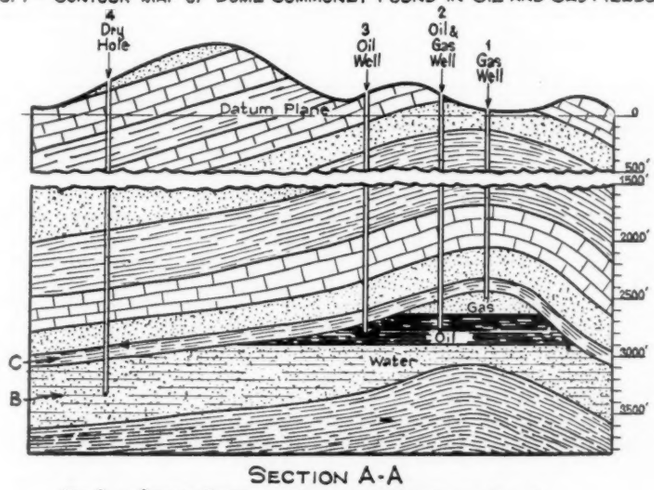


FIG. 1 - CONTOUR MAP OF DOME COMMONLY FOUND IN OIL AND GAS FIELDS



SECTION A-A

FIG. 2 - CROSS SECTION THROUGH DOME IN FIG. 1

Estimation of Gas Reserves

Gas is commonly measured by an application of Boyle's Law for gases. This law, discovered by Robert Boyle (1627-1691), an English chemist and physicist, reads: "At a constant temperature, the volume of a given quantity of any gas varies inversely as the pressure to which the gas is subjected."

This law may be expressed by the formula

$$PV = a \text{ constant}$$

in which "P" is the pressure and "V" the volume, a formula which is not nearly as formidable as at first appears. Figure No. 3 shows a graphic illustration of the law. "A" represents a container with a volume of one cubic foot. This container is filled with gas at a pressure of one unit of weight which may be considered the pressure at which gas is measured for selling purposes.

If the one cubic foot of gas in container "A" be gradually compressed by moving the piston downward, the temperature be kept constant, and no gas be permitted to escape, it will be found necessary to increase the pressure to two units of weight in order to move it half way down the cylinder or to such a position that the same amount of gas occupies a volume of only one-half of one cubic foot. See Figure No. 3 (B). The quantity of gas by weight has not changed but the pressure has been doubled and the volume occupied by the gas has been reduced one-half.

Similarly if the pressure on the piston be increased to four units of weight, the volume of the gas will be reduced to one-fourth of one cubic foot. See Figure No. 3 (C). In each case, however, the product of the pressure times the volume will be the same, that is, a constant quantity; thus

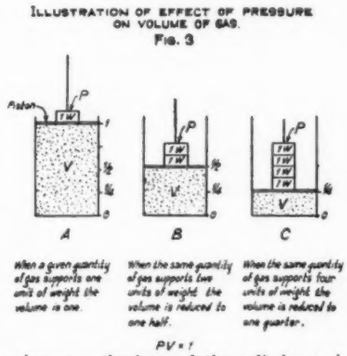
1 unit pressure × 1 cu. ft. = 1 (a constant)
2 units pressure × ½ cu. ft. = 1 (a constant)
4 units pressure × ¼ cu. ft. = 1 (a constant)

Note: (At high pressures, variations in the law not treated in this paper occur which are susceptible of mathematical treatment.)

Basis of Estimates

Looking at the matter in another way, let the gas be in the condition shown in Figure No. 3 (C), with the pressure four units and the volume one-fourth of one cubic foot. If a pump is connected to a valve near the base of the cylinder and gas pumped into the container, the piston will rise, and if pumping is continued until the piston has risen to the original position it occupied in (A) the volume of the space then occupied by the gas will be one cubic foot, but in this case the cubic foot of gas will be under four units of pressure instead of one unit as in case (A). Hence, there is four times as much gas in the container as at first. This is merely another way of illustra-

ILLUSTRATION OF EFFECT OF PRESSURE ON VOLUME OF GAS.
FIG. 3


Piston
P
1 lb.
V
1
1/2
0
A
B
C
2 lbs.
4 lbs.
When a given quantity of gas supports one unit of weight the volume is one.
When the same quantity of gas supports two units of weight the volume is reduced to one half.
When the same quantity of gas supports four units of weight the volume is reduced to one quarter.
PV = 1

ing Boyle's Law which may now be expressed as follows: In a given volume, the quantity of gas present—by weight—is directly proportional to the pressure, or the greater the pressure the greater the amount of gas present, other conditions remaining equal.

Recognition of the fact that the escape of gas from a reservoir is accompanied by a proportional reduction in pressure forms the basis for the estimation of gas reserves underground. For example, if from a given underground reservoir having an original pressure of 1,000 pounds per square inch, gas is withdrawn to the amount of 50,000,000,000 cubic feet (measured at the selling pressure base) and this withdrawal causes the pressure in the reservoir to decrease to 900 pounds per square inch, the conclusion is drawn that one-tenth of the total amount of gas in the reservoir has been removed. Therefore, the total amount of gas originally present must have been 500,000,000,000 cubic feet. This calculation is based on the assumption that the pressure throughout the entire reservoir was reduced to 900 pounds per square inch. In the case of a large gas field penetrated by a number of wells, it may be found that the early production has been obtained from only a part of the field or pool. In this case the reserves of the producing area are determined by use of Boyle's Law and the remainder of the field is judged by a comparison of its wells with those affording production.

Practical Application

The practical application of the above method is illustrated in Figure No. 4, a chart which was used in the appraisal of a West Virginia gas field at the end of 1923. The first two wells in the pool were completed in 1909 with an initial rock pressure of 525 pounds. Other wells drilled during the first succeeding years have almost the same or slightly lower rock pressures depending on their location with reference to the area from which gas was being withdrawn.

Beginning about 1913, the acquisition and preservation of rock pressure readings and production records were further systematized so that when the field was valued in 1924, the average rock pressures and the metered production could be plotted graphically as shown in curves "A-B" and "D-E" respectively. "D-E" is a curve of cumulative production plotted against the remaining rock pressure. The future production is indicated by extending the graph "D-E" to the limiting rock pressure which in this example is zero pounds or atmospheric pressure. The limiting rock pressure in each case is determined from a study of similar fields.

The relation between rock pressure decline and the metered gas production which accompanies this decline is shown by the two curves "A-B" and "C-F" from which it is possible to estimate the total production of the field.

Care must always be exercised in the interpretation of rock pressure data. Some sands are essentially water dry. In others, the water migrates very slowly as pressures in the gas pool are reduced. In certain fields where the sands are open, water encroachment is a serious factor as the water gradually replaces a portion of the space originally occupied by gas. This results in a partial maintenance of high pressure, and unless taken into consideration, may lead to erroneous conclusions as to gas reserves.

Other methods are occasionally useful in estimating gas reserves. One of these is known as the porosity-pressure method which is also based upon Boyle's Law.

Another is known as the production-decline method. In the first, the area, thickness, porosity of the sand and the pressure are used as factors to determine the amount of gas in a pool.

In the second, the future performance of a well or field is based upon its past production and the rate of decline. When the available data permits, reserves are estimated by all methods as a check.

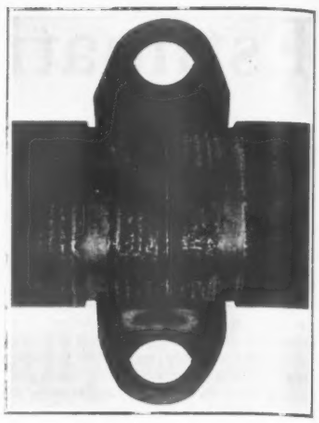
In the estimation of gas reserves, consideration must be given the character of the producing formation and depth and history of gas pools in the same general territory or in similar geologic formations. With knowledge of these general factors and with the specific information afforded by the particular field under consideration, it is possible to reach sound conclusions as to the gas reserves proven as of any particular date.

NEW PIPE LINE JOINT PRODUCT OF WORLD WAR

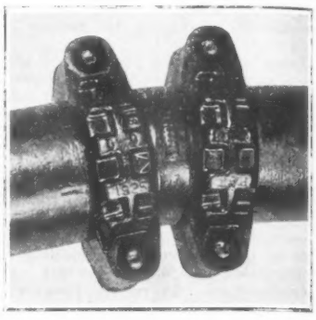
The Victaulic pipe line joint is a product which had its inception during the recent world war. It was invented by a British Army engineer during service in the trenches, when he discovered that by its use the construction of pipe line systems could be greatly facilitated.

Its service in warfare resulted in its being adapted to commercial distribution, and it now has a place in the petroleum industry of the United States, and many South American countries, where it serves in natural gas, gasoline, and petroleum lines. Over 900 miles of lines in South America are equipped with this type of joint.

The Victaulic Company of America was formed in June, 1925.



Cross Section Victaulic Joint



Victaulic Setting Piece

FIG. 4

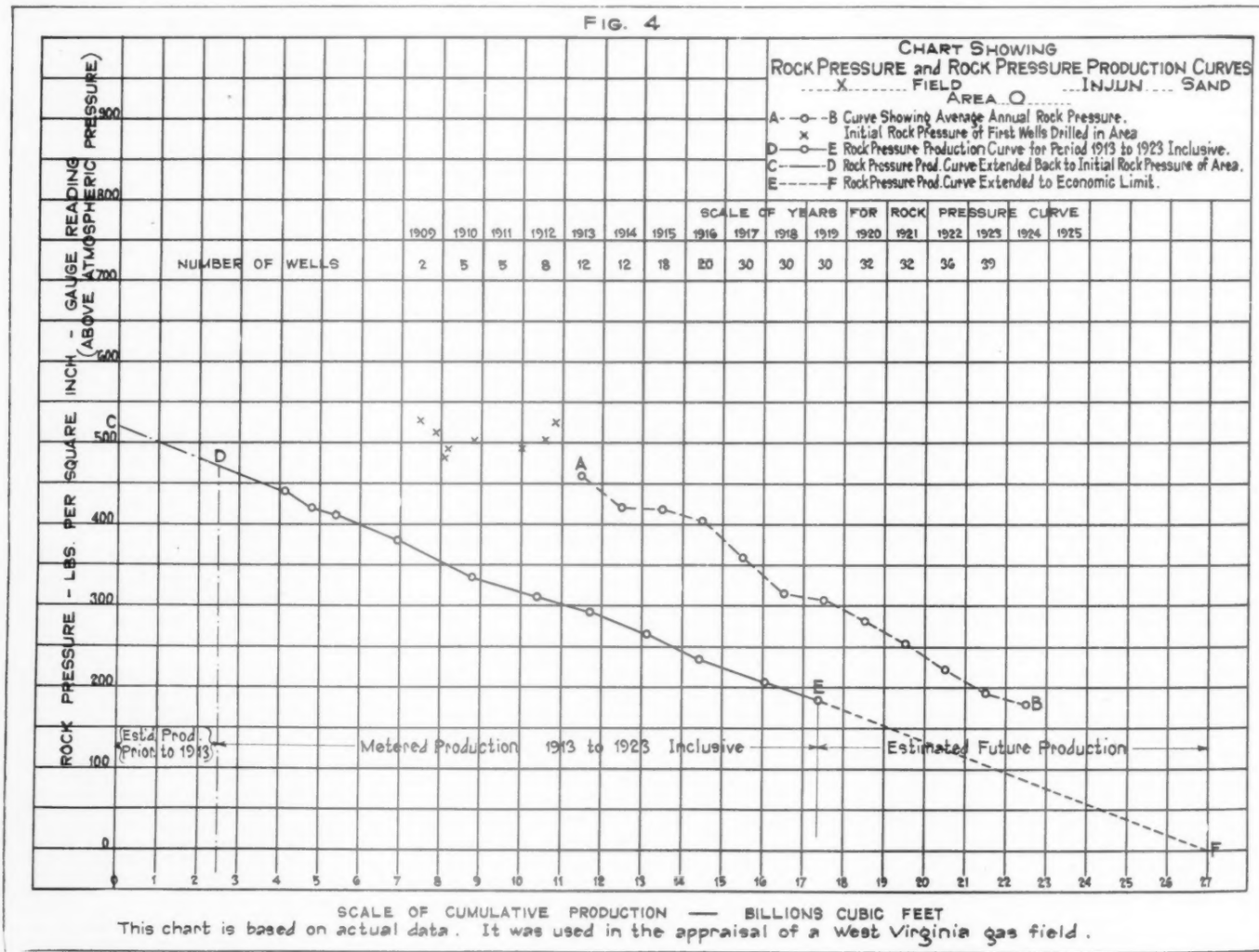


CHART SHOWING
ROCK PRESSURE and ROCK PRESSURE PRODUCTION CURVES
X FIELD AREA O INJUN SAND
A—o—B Curve Showing Average Annual Rock Pressure.
x Initial Rock Pressure of First Wells Drilled in Area
D—o—E Rock Pressure Production Curve for Period 1913 to 1923 Inclusive.
C——D Rock Pressure Prod. Curve Extended Back to Initial Rock Pressure of Area.
E——F Rock Pressure Prod. Curve Extended to Economic Limit.
SCALE OF YEARS FOR ROCK PRESSURE CURVE
1909 1910 1911 1912 1913 1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925
NUMBER OF WELLS 2 5 5 8 12 12 18 20 30 30 30 32 32 36 39
ROCK PRESSURE - LBS. PER SQUARE INCH - GAUGE READING (ABOVE ATMOSPHERIC PRESSURE)
900
800
700
600
500
400
300
200
100
0
C
D
A
B
E
F
(Estd. Prod. Prior to 1913)
Metered Production 1913 to 1923 Inclusive
Estimated Future Production
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
SCALE OF CUMULATIVE PRODUCTION — BILLIONS CUBIC FEET

This chart is based on actual data. It was used in the appraisal of a West Virginia gas field.

ORGANIZATION OUTLINE OF

The Mid-Continent Oil & Gas Association

A federated non-profit organization devoted to the interests of all branches of the Petroleum Industry in the Southwest.

THE GENERAL ASSOCIATION

Office: 505 Cosden Building, Tulsa, Oklahoma.

Finance: Supported by direct voluntary contributions based upon an annual budget.

Scope of Activity: National or general matters not peculiar to any one State but affecting all five States of the Mid-Continent Field and Gulf Coast, such as—

- Federal Taxation
- Federal Legislation
- General Public Relations Work
- Standardization of Lease Contract
- Economic Research
- Co-Operation with Departments of National Government
- Other Matters in which the Operators of the Five States have a common interest.

AFFILIATIONS: Three Local Divisions and The Petroleum Safety Council

The Kansas - Oklahoma Division

Office: 505 Cosden Bldg., Tulsa, Okla.

Finance: Supported by dues of $25.00 per individual member per annum.

Scope of Activity: Matters particularly affecting the industry in Kansas and Oklahoma, such as—

- State Legislation
- State Taxation
- Local Public Relations Work
- Co-Operation with State Departments
- Indian Laws and Regulations
- Conservation Laws and Regulations, Etc.

The Texas Division

Office: 1507 Kirby Bldg., Dallas, Texas.

Finance: Supported by dues of $25.00 per individual member per annum.

Scope of Activity: Matters particularly affecting the Industry in the State of Texas, such as—

- State Legislation
- State Taxation
- Local Public Relations Work
- Educational Work
- Co-Operation with State Departments
- Conservation Laws and Regulations, Etc.

The Louisiana - Arkansas Division

Office: 34-35-36 American National Bank Bldg., Shreveport, La.

Finance: Supported by dues of $25.00 per individual member per annum.

Scope of Activity: Matters particularly affecting the Industry in the States of Louisiana and Arkansas, such as—

- State Legislation
- State Taxation
- Local Public Relations Work
- Co-Operation with State Departments
- Conservation Laws and Regulations, Etc.

This Space Contributed by a Member of the Mid-Continent Oil & Gas Association.

Methods for Detection of Gas Leakage

Problems of Natural Gas Distributing Companies Outlined and Ways to Minimize Big Loss Are Described

By W. G. Hagan
The East Ohio Gas Co., Cleveland, Ohio

It is generally conceded by gas companies throughout the country that certain standard methods of constructing and repairing distribution systems should be followed if satisfactory operation of the system, from a leakage standpoint, is to be obtained.

Gas companies operating in large cities, for instance, find that the large percentage of broken cast iron mains occurs in sizes under 6 inches in diameter and that a very small percentage of broken mains occurs in cast iron mains in the larger sizes. The large percentage of breaks in the smaller sizes of cast iron mains occurs in streets over which there is heavy travel and in which there are many underground structures belonging to telephone companies and other public utilities.

Double Lining

Most gas companies realize the importance of double lining streets under which there is likely to be extensive systems of electric conduits or on which street car tracks are planned for sometime in the future. Important thoroughfares carrying a heavy automobile traffic come under this classification. These roadways are usually constructed on heavy concrete bases, sometimes reinforced with wire mesh or steel bars. Repairs to gas mains or services laid under pavements of this kind are very expensive. In some cases it has been found to be more economical to lay a new main on each side of the street and abandon the defective gas main than it is to repair the old one. This is especially true in the outlying sections of town where a small size main develops numerous leaks, and where the cost of making the openings in the street to repair both the main and the service, together with the cost of repairing the pavement after the leaks have been repaired, are unusually high. On the other hand, in important thoroughfares it is not always possible to find a new location in the street and while the cost of maintaining the line in what might be considered an undesirable location is excessive, the presence of other underground structures absolutely prohibits any change from the original layout.

Location of Lines

In view of the expense and the difficulties encountered in repairing mains located under pavements, it appears to be desirable, whenever it is possible to do so, to locate gas mains between the curb stone and the sidewalk or under the edge of the sidewalk where the space between the curb and the sidewalk is not sufficient to accommodate the main. Leaks occurring in gas mains so located are repaired at comparatively small expense, and experience with this system indicates that leaks ordinarily neglected in cases where mains are located under the pavement, are given prompt attention. Mains located between the sidewalk and the curbstone are subject to somewhat less vibration from street cars and trucks than mains located under the pavement, and ordinarily remain gas tight over a longer period.

Leakage from service lines occurs most frequently in lines passing under street car tracks on the opposite side of the street. Defects causing this leakage of gas usually result from electrolysis and the points at which the leakage occurs depends upon the location of the other underground structures and the relative amount of current which is being carried by them. By constructing a main on each side of the street, most of the damage due to electrolysis to service lines is eliminated.

Service lines occasionally become defective at the points where they pass under curbstone where the curbstone is drained by a tile laid in cinders and at the point where they pass through the foundation of the building. These points should receive special protection.

Corrosion Problems

The protection of service lines and mains against soil corrosion has not received the proper attention from gas companies during the past years. It seems to be inconsistent to construct a distribution system of cast iron and use bare steel pipe in the service lines. This is especially true where the street is single lined and the services are laid across the street.

The use of steel line pipe encased in a protective coating in place of cast iron mains appears to be gaining favor with companies throughout the country. By the substitution of the steel main for the cast iron main two of the problems encountered in distribution systems made up of cast iron mains, namely, broken mains and inefficient joints, are practically eliminated and in their stead is encountered the serious problem of protecting the steel main from corrosion. Whether or not it will be possible at some future time to obtain the same number of years of service from a properly coated steel main made of metal impervious to soil corrosion as it is possible to obtain from a cast iron main under the same soil conditions is an open question. A great deal of experimental work is being done on the problem of protecting pipe against soil corrosion and while considerable progress has been made by the various gas companies and manufacturers of steel pipe in this work, there still remains much to be done.

When Street is Repaired

The opportunity of correcting poor construction in a gas distribution system which is causing trouble on account of leakage on a given street, presents itself when the street is being repaved. After the paving contractor has removed the old pavement it is usually possible, by working promptly with enlarged gangs, to completely overhaul mains and services, if necessary. Opinion among gas companies differs as to how much work should be done on the services and main when a street is being repaved. It does not necessarily follow, of course, that the distribution system in the street needs to be thoroughly overhauled because the street needs a new pavement. At the same time, all public utility companies should inspect their property in these streets and at least put them in condition such that no general repairs will be necessary for 10 years.

During past years it has not been uncommon for companies building underground conduits and vaults to "build-in" the gas mains solidly within the walls of their structures. In some cases these conduits encased in concrete have been built directly on top of the gas main. In other cases gas mains have been hemmed in so tightly between two conduits that it is impossible to repair them. Mains so located are often strained or broken while such work is in progress.

Leakage Inspection

There is wide difference of opinion among gas companies as to when a gas main should be inspected for leakage. Natural gas companies have their high pressure transmission lines patrolled several times each week while their high pressure distribution lines which feed the regulators scattered throughout the city are patrolled each day by the men who service the regulators. In addition to the patrolling of lines of this kind it is advisable to spud them once each year. It is not always practical to spud lines located in streets occupied by telephone and electric cables in which case good results are obtained by examining the underground vaults, which are very numerous in such streets.

A comparatively inexpensive way of conducting an investigation of this kind is to have assistants from the laboratory of the company gather samples from the vaults along the street, in pint bottles equipped with self-sealing stoppers, and return them to the laboratory for the test. Three laboratory assistants can usually gather and test 100 samples each day. Samples containing mixtures of about 3 to 13 per cent of natural gas or about 2 to 20 per cent of coke oven gas will explode if a spark or flame is introduced. Each bottle is tagged, showing the location of the vault from which the sample was taken. When the laboratory finds samples containing explosive mixtures, the maintenance department is notified at once. The laboratory is often called upon to advise the maintenance department as to the relative quantities of gas in series of vaults in a street.

Analysis Locates Blame

This method of analyzing gas samples is useful in the investigation of explosions in vaults and buildings. Ordinarily explosions occurring in any part of the city in which gas mains are located are attributed to leaking gas until the actual cause is revealed. Gasoline and other explosive liquids are frequently dumped in the sewer from garages or cleaning establishments which cause explosions which may be laid to leaking gas unless the gas company obtains information to disprove the claim.

The amount of gas leakage from mains and service lines resulting from damage caused by electrolysis, depends to a large extent on the condition of the street railway system. A gas company operating in a city in which there is a prosperous well-maintained street car system, has little trouble from electrolysis as compared with the company operating in a city in which the street car system is poorly maintained. In the former case, the railway company is usually willing and anxious to correct, in so far as it is possible, all cases of trouble on this account as soon as it is brought to their attention. The matter should be laid before them, however, by gas company representatives who are familiar not alone with the damage caused by electrolysis to the mains and service lines, but who are trained sufficiently in electric railway engineering and acquainted with the local railway system to the extent, at least, to intelligently discuss and suggest the proper methods of correcting the trouble.

Electrolysis

One method of handling the situation is to have in the employ of the gas company one or two men working under the direction of a consulting electrolysis specialist who lays out the work to be done from time to time and who, after studying the reports and charts gathered by the assistants, consults with the railway company on ways and means of eliminating the defects. At times it is found to be necessary for both the railway company and the gas company to make changes in their construction to remedy the situation; in other cases it may be feasible for the railway company only to make inexpensive changes in their construction or their method of operating, to bring about the desired results.

Inspecting Other Work

During recent years companies owning conduits and pipe lines find it expedient to carry on a system of daily inspection of all work performed by other companies where their property is endangered. This system of inspection is not, and should not be, carried on in a manner which will antagonize the other companies. On the contrary, the inspection should be performed so as to help rather than hinder them. The relationship which exists between the workmen of the municipality and the various public utilities is naturally affected by the relationship of their various officials. If cordial relatons exist between the officials of the electric light company and the officials of the gas company, it naturally follows that about the same relationship exists between the foremen and the workmen of their respective companies.

In connection with the repairing of mains in advance of paving and with repairing of mains constructed under pavements, companies should bear in mind the fact that there is a strong public opinion against the breaking of new pavement for repairs of any kind to underground structures. A utility can readily acquire a reputation for carelessness in this respect, which might finally result in unfriendly relations not alone with the city officials, but with the general public as well.

Problem Is Intensified in Cities

Large percentage of broken cast iron mains occurs in sizes under 6 inches and very small percentage of broken mains occurs in cast iron mains of larger sizes.

Many companies realize importance of double lining streets under which there is likely to be an extensive system of electric conduits or on which street car tracks are planned for some time in the future.

In view of expense and difficulties encountered in repairing mains it is desirable, where possible, to locate them between curb stone and sidewalk or under the edge of the sidewalk.

Analyzing gas samples from vaults in streets often prevents damages and places blame for trouble where the guilt lies.

Close co-operation with other public utilities is beneficial to all concerned.

During recent years companies owning conduits and pipe lines find it expedient to carry on a system of daily inspection of all work performed by other companies where their property is endangered.

METERS
For Every Kind of Service

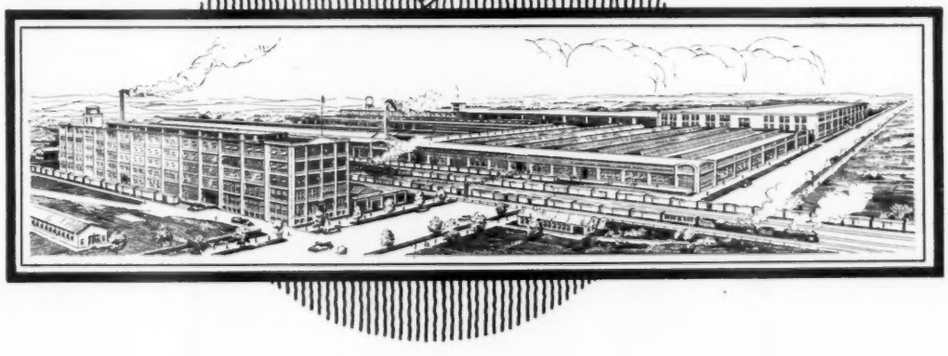
PITTSBURGH-EQUITABLE PRODUCTS

EQUITABLE DIVISION
Emco Standard Domestic Gas Meters
Emco Curb Box Meters
Emco Large Capacity High Pressure Gas Meters
Emco Balanced Valve Regulators
Emco Service Regulators
Emco Water Heater Regulators
Emco Pressure and Volume Recording Gauges
Wylie Proportional Meters
Crawford Sensitive Regulators
Combined Recording Gauge
And Other Equipment Used In The Gas Industry

PITTSBURGH DIVISION
Arctic Water Meters
Tropic Water Meters
Keystone Water Meters
Eureka Water Meters
Keystone-Compound Water Meters
Westinghouse Positive Gas Meters
Westinghouse Proportional Gas Meters
Ironclad Cast-Iron Dry Gas Meters
Westinghouse Orifice Meters
Keystone Gasoline Meters

Also Manufacturers of Meters For Air, Hot Water, Oil, Beer and Other Fluids and Water and Gas Meter Provers

THE NEXT THREE PAGES SHOW SOME PRODUCTS OF INTEREST TO YOU.



Pittsburgh Equitable Meter Co.
Pittsburgh, Penna.

EMCO No. 5 Pressed Steel Type Large Capacity Gas Meter.

EMCO No. 4 Large Capacity Positive Gas Meter.

Westinghouse Fluid Positive Meter.

Ga

MET

PITTSBURGH EQUITAB

PITTSBURGH

Emco No. 0 Cast Iron Curb Box Meter.

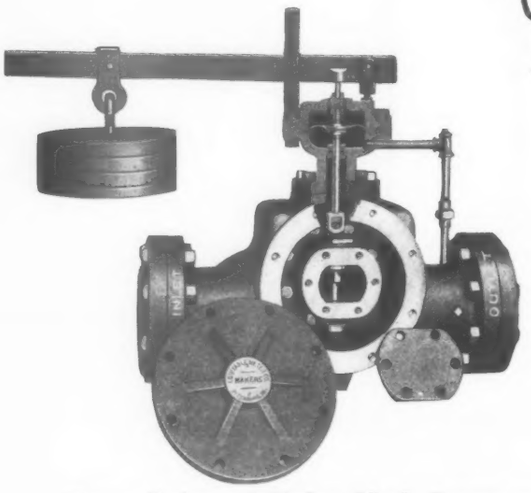
Emco No. 0 Cast Iron Dry Gas Meter, Domestic and Small Industrial.

Gas
TERS

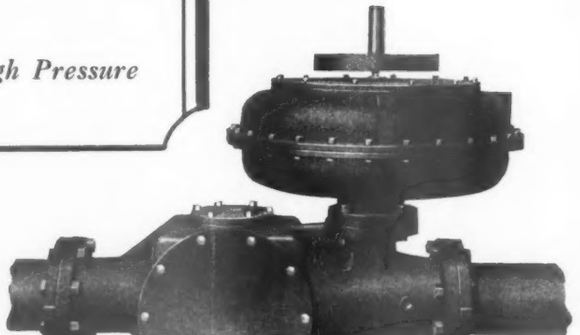
EQUITABLE METER CO.
TSBURGH, PA.

Ironclad Cast Iron Dry Gas Meter, Domestic and Small Industrial.

High and Low Pressure BALANCED VALVE REGULATORS



Emco Balanced Valve High Pressure Regulator.



Emco Balanced Valve Low Pressure Regulator.

Pittsburgh Equitable Meter Co.

Pittsburgh, Penna.

Natural Gas for Domestic Purposes

Convenience, Cleanliness and Economy of Time Are Important Factors in Selection of Proper Fuel for Homes

By George E. Whitwell*
General Manager, Equitable Gas Co., Pittsburgh, Pa.

It is difficult to think of competition without associating it with price. Generally speaking, the price of an article compared with the price of another article is an important, if not the most important, first consideration to average purchasers.

Second thought, however, indicates that price alone may be only one factor, and often a very small factor, in determining the value of any article. This is true of fuels. With them, our interest is not primarily in the cost of the fuel itself but in the cost of the accomplishment of a unit of work. Even then, value may not be entirely determined for there may enter other considerations. Convenience, cleanliness, healthfulness, economy of time and excellence of the finished product have a very important bearing upon the choice of fuel and, within reasonable limits, tend to offset an adverse price.

Cost of Using is What Counts

Generally speaking, it isn't the cost of a fuel that counts; it's the cost of using it. Nevertheless, it is of interest in any study of natural gas to look into this matter of price and review a little the circumstances which have determined costs as they are found today.

Natural gas started out, in most cases, with coal and wood as competitors. When gas was first offered to the public, coal and wood had been used for cooking and househeating, and coal had been used by industries. In other cases, coke, oil and kerosene were competitors of the new fuel.

It was considered necessary, at first, to price gas so that it would cost less than the other principal sources of heat energy. In many localities, flat rates per month of so much per stove or room heated or range or other gas equipment were charged.

There were no inducements, with flat rates, to purchase economical burners and equipment or to use gas carefully. Therefore, crude burners were installed in appliances designed for other fuels. Gas was wasted. Hazards were developed in the use of gas. Unsatisfactory service was common. A very false impression regarding the real value of natural gas was developed. The regard of communities for their gas companies was far from the best. Serious lack of confidence in the dependability of the supply of gas grew without restraint.

When well productions declined and fields were extended, the necessity arose for price increases. Reasoning that natural gas rates were once lower, the public concluded that gas had become expensive. Having no definite knowledge as to actual relative cost of different sources of heat energy, and instead of comparing the cost of using gas with the cost of using other fuels, it was easiest to compare the existing gas rates with previous gas rates.

The present generation of gas men has faced a general mistaken idea as to the value of gas for domestic, commercial and industrial uses and also as to the merits of gas as dependability, cleanliness, control, safety and convenience.

Cost of Fuels

Any comparison of the cost of fuels must necessarily be based upon local conditions. For purposes of illustration, current prices to the domestic trade in western Pennsylvania have been used. The tabulations in Table 1 show the relative cost of base fuel without taking into consideration utilization efficiencies or auxiliary costs:

*Acknowledgment is made of the valuable assistance rendered in the preparation of this article by E. J. Stephany, Superintendent of Domestic Gas Sales and Service, Equitable Gas Co.

Why Natural Gas Is Preferable

Generally speaking, it is not the cost of the fuel which counts, it is the cost of using it.

In order to obtain a true comparison of gas and other fuel costs, it is necessary in the case of all other fuels to add fuel handling and maintenance costs. For example, to the cost of coal must be added the cost of kindling, the cost of removing ashes and other items. To the cost of oils must be added all or some of the following: Leakage, pumping costs, air or steam for atomization and maintenance of equipment.

Even with the above only the gross cost is obtained. These costs should further be corrected by considering the utilization efficiency or the percentage of total heat which can be put to work. In addition, the convenience factor has become more important than mere cost.

Natural gas companies have been handicapped by wasteful appliances used by their customers. The American Gas Association Testing laboratory at Cleveland is doing a great work in solving this problem.

Gas is convenient. It is clean. It can be easily controlled. It is instantly available. It requires no storage, no preparation, no labor in handling, no removal of refuse and no specially skilled operators. It can be burned without objectionable odors or smoke. It is paid for after use.

TABLE 1—Relative Base Fuel Costs

Fuel	Unit Cost	Heating Value B.t.u.	Cost per Million Heat Units
Natural Gas	$ .60 per MCF	1,100 per Cu. Ft.	54.6c
Natural Gas	.45 per MCF	1,100 per Cu. Ft.	40.8c
Manufactured Gas	1.25 per MCF	530 per Cu. Ft.	235.8c
Bituminous Coal	6.50 per Ton	13,500 per Pound	24.1c
Anthracite Coal	15.00 per Ton	12,500 per Pound	60.0c
Coke	10.00 per Ton	12,500 per Pound	40.0c
Fuel Oil	.07 per Gal.	140,000 per Gallon	50.0c
Kerosene	.13 per Gal.	125,000 per Gallon	140.0c
Wood	7.00 per Cord	7,500 per Pound	24.6c

TABLE 2

Fuel	Unit Cost	Amt. Required	Total Cost
Natural Gas	$ .60 per MCF	22.0 Cu.Ft.	1.3c
Soft Coal	6.50 per Ton	7.8 Pounds	2.5c
Coal Oil	.15 per Gal.	2.3 Pounds	5.4c
Gasoline	.27 per Gal.	1.1 Pounds	4.6c
Electricity	.03 per K.W.H.	1.7 K.W.H.	5.1c

To some of the above bare fuel costs must be added other items in order to obtain the total cost per heat unit. For example to the cost of coal must be added the cost of kindling, the cost of removing ashes and other items. To the cost of oils must be added all or some of the following: Leakage, pumping costs, air or steam for atomization and maintenance of equipment. In order to obtain a true comparison of gas and other fuel costs, it is necessary in the case of all other fuels to add fuel handling and maintenance costs.

Even with the addition of these factors to the bare fuel costs shown above, we have obtained only the gross cost of the fuel. These gross costs must be further corrected by considering the utilization efficiency or the percentage of total heat which can be put to useful work. Let us take for example, the efficiencies as found in domestic househeating:

Gas boilers and furnaces	75%
Gas burners in coal equipment	40% or less
Coal	25-40%
Oil	50-65%

It can easily be seen, from this one example, that very erroneous ideas as to the costs of using various fuels would be obtained from comparisons which do not take into account the utilization efficiencies. The figures for gas in appliances designed for its use and gas in coal equipment also show that the method of use is of utmost importance.

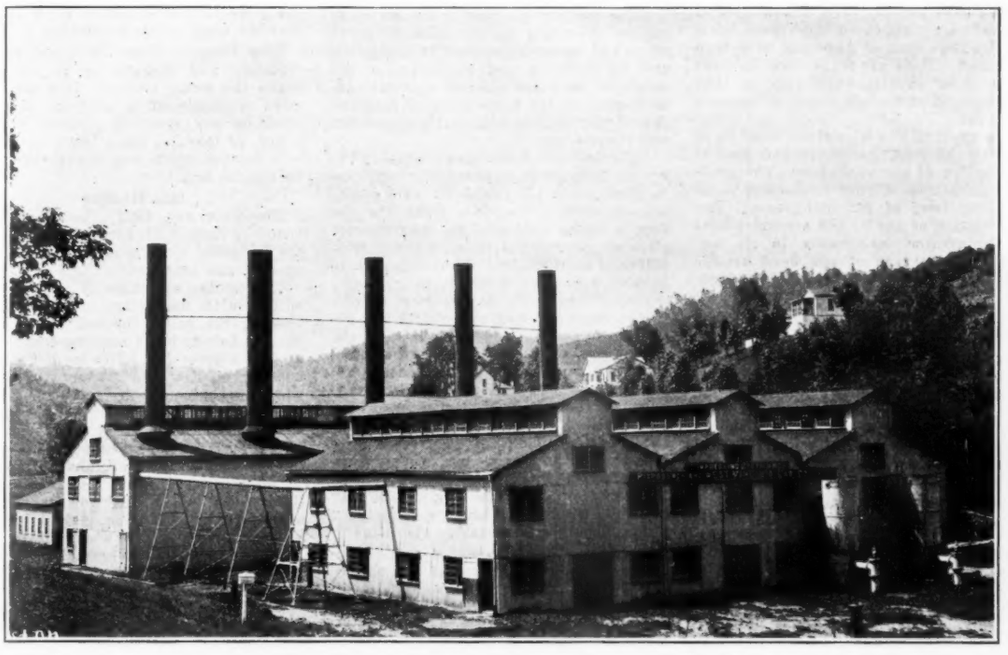
The housewife of the present day is unwilling to fire a kitchen range with coal or wood when gas, electricity or oil can be had. The convenience factor has become more important than mere cost. The time element is also important.

Cooking tests made at the Ohio State University in 1927 for a dinner for six people is shown in Table 2.

Final Cost Different

To further illustrate the difference between bare cost of fuel and the cost of using it for cooking, we may cite a test made in New England where manufac-

THE SKIN CREEK COMPRESSING STATION



Outside view of large compressing station of Pittsburgh and West Virginia Gas Co. on one of the lines which extend from the mountain state to the steel city.

tured gas for cooking costs no more than anthracite coal after actual heat utilized, cost of kindling and handling costs were considered. Table I in this article would indicate a ratio of 4 to 1, but the final cost figures are quite different.

In another article in this issue will be found a tabulation showing calculated costs of delivered heat units after giving effect to efficiency. (See the article by A. Hurlburt.)

While it is impossible to treat in so small a space the question of the true place that price must take in any consideration of the competitive value of fuels, enough has been brought out to indicate that price cannot be separated from efficiency. If we consider price at all, we are not considering the price of a heat unit in the raw fuel but we are considering the cost of the delivery at a desired place of sufficient heat units to accomplish a given object. The question of efficiency cannot be neglected, neither can we neglect the operation and maintenance costs which accompany heat utilization, nor in fact can we neglect in the ultimate analysis such costs as the fixed charges on equipment.

Natural gas for domestic use in competition with other fuels immediately, therefore, becomes dependent upon the equipment used for its combustion, and it is well for us to consider carefully the question of the kind that is found upon the lines of natural gas companies and whether the problem of domestic gas sales does not depend largely upon the installation of better, safer and more efficient equipment.

Gas Burning Equipment

As previously pointed out, natural gas companies have been handicapped by the wasteful appliances used by their customers. Government publications have shown the immense amount of gas wasted by low-set cooking range burners, short coil water heaters and burners placed in appliances which were designed for the use of solid fuels. Most gas companies have made progress in informing the public regarding more modern appliance design, proper burner adjustment and correct usage. Recommendations have not been uniform because they have been based on local laboratory tests, published data from various sources or merely ideas of the particular individuals coming in contact with the public.

Now, however, a definite and forceful help, a national institution with a national viewpoint, has stepped in to help us. The American Gas Association Testing Laboratory is at work testing various kinds of gas appliances. Approval requirements for ranges, tubing, space heaters, water heaters, gas furnaces, and gas boilers have already been drawn up and lists of many approved appliances bearing the Blue Star of Approval have been published. Tests are made with different gases under varying conditions so that the approval of the laboratory is national in scope.

The effect of the laboratory must be to improve the safety, economy and general satisfaction of gas appliances. The gradual elimination of poor appliances must raise the level of gas utilization. The appreciation of gas by the general public due to greater satisfaction in its use and the wider use of gas must result. Thus the competition from other fuels will be minimized.

Phases of Competition

While natural gas competition is usually considered as competition from other sources of heat energy, the following passage from the booklet of the American Gas Association describing "The Blue Star Plan" is of interest:

"Our big competition today in the domestic market is not solely with competing fuels, such as oil, coal and electricity. Equally important are the other products designed to increase the comfort of the home, with which we must always compete for our rightful portion of the housewife's time and attention, and for our share of the dollar she is spending. This variety of competition can be met only by shaping our sales program in a concerted manner, surrounding our product with new styles, fads and habits of a more interesting nature to women, and through a systematic sales follow-up, maintaining that interest at all times.

"The Blue Star Plan meets the necessity for presenting our product in a newer and more interesting and attractive aspect today, by establishing an entirely new standard of gas service for greater home comfort and convenience locally and by trade-marking and featuring that trade-mark thereafter locally and nationally.

"The primary purpose is to sell more gas by providing for the installation of more and better appliances in the home, and by creating and retaining in the minds of the home makers, a greater appreciation of the importance of domestic gas service as an aid to their comfort and convenience.

"The feature of the plan regarding the use of high grade appliances, constitutes to some extent the fulfillment of a public responsibility. It arises from the desire to create a demand for domestic appliances constructed in accordance with standard specifications of the industry, to safeguard the public health, and to guarantee efficient and satisfactory service to the customer, and thus fulfill our obligation to the American public. But the commercial results of trade-marking and thus encouraging the sale of better appliances are no less important to the industry than its significance from the standpoint of safety. Just as a poor appliance is a handicap to greater sales of gas and an invitation to our competitor, so a quality appliance, rendering satisfactory service day in and day out, is the industry's better salesman for promoting the use of gas in the home."

Other Advantages of Gas

There are other phases of competitive value, some difficult to measure.

Gas is convenient. It is clean. It can be easily controlled. It is instantly available. It requires no storage, no preparation, no labor in handling, no removal of refuse and no specially skilled operators. It can be burned without smoke or objectionable odors. It is paid for after use.

To be specific—Gas in the laundry can heat the water, boil the clothes, keep the water in the washer warm, dry the clothes and supply the heat for ironing them. The majority of operations can be automatically controlled. The laundry is clean and a pleasant place in which to work and the total work is minimized. No other fuel is so useful while making possible such great economies.

How else can water be heated so conveniently and cheaply as by an automatic gas water heater? Hot water always available at a uniform temperature, in any quantity desired and at a cost, at most, of but a few cents a day, is a service which any household should be able to buy.

Gas Heating

The February, 1927, "Industrial Bulletin" of Arthur D. Little, Inc., contains the following dissertation on the advantages of gas heating:

"Particular attention is paid to high efficiency in the equipment supplied for burning the gas. Instead of installing the gas burner in an existing coal heater, as is the general practice in domestic oil burning, a new gas heater is supplied which is specially designed to recover the maximum amount of heat from the gas flame. Furnaces of this type give operating efficiencies 10 per cent to 15 per cent higher than oil, and 25 per cent to 30 per cent higher than coal, when these fuels are burned in conventional coal heaters. Similar gains in fuel economy are possible when oil is used in specially designed heaters, and some manufacturers of burner equipment are prepared to supply such heaters when desired. On account of the lower prime cost of oil, the realization of these higher efficiencies is not as likely to offset the added capital expense, and as yet the converted coal heater is by far the more common practice in domestic oil burning installations.

"The distribution of gas in underground mains is unaffected by weather or traffic conditions, and this service is among the most dependable of the utilities. The householder is relieved of the necessity of buying and storing fuel in advance, paying for his fuel after it has been used."

While facing competition from other fuels, gas itself has entered as a competitor. The gas refrigerator, now available in at least four different makes, gives promise of becoming a large factor in the field of mechanical refrigeration. The absence of noise, wear and tear and maintenance costs is appealing. The low operating cost will widen the market for mechanical refrigeration. The accuracy of control and absolute safety are of large importance.

A very interesting article in the January issue of "House and Gardens" entitled "The New Era of Gas" ends with the following paragraph:

"Thus it is easy to see that gas has been marching on and that it is rapidly conquering new fields. Witness, for example, some of the things it has done in a very few years since illuminating by gas was its only function in the home; gas ranges, ovens, burners, gas fired furnaces, gas fired irons, gas fueled incinerators, gas heated laundry dryers, gas heated washing machines, radiant space heaters, gas radiators, gas heated electric ironers, gas lighting and the last recruit—gas refrigeration. This is progress indeed."

Although gas has its competitors in every one of its many applications, its use in the modern appliances with a complete understanding of its manifold advantages and backed by the helpful cooperation of the gas company with its customers, leaves competition as a help to further advancement rather than a hindrance to the progress of gas.

Determining Pipe Line Diameters

Volume-Pressure Conditions and Length of Transporting Lines Are the Factors Which Must be Considered

By Edward D. Leland

Assistant to Vice President, Equitable Gas Co., and Pittsburgh & West Virginia Gas Co.

In planning gas lines for transporting natural gas from the various fields to points of distribution, or consumption, it is necessary to determine the required diameter of pipe, the proper thickness of metal, and the length of the conveying lines.

Pipe lines may vary from only a few miles, to hundreds of miles in length, gas pressures range from around atmosphere, up to more than 1,000 pounds per square inch, while pipe diameters of from 1 inch to 36 inches are not unusual.

The diameter of pipe that should be used in any particular case is largely governed by the volume and pressure of the gas, to be transported through a given length of line.

The thickness of metal required depends upon the pressure of the gas, the diameter of the pipe and the tensile strength of the metal.

The length of line, of course, largely depends upon the distance between the gas field and the point of distribution.

Proper Size Important

Since these various controlling factors are usually found to be quite different in each of the numerous natural gas transportation problems that are met with, careful study is required, in order to avoid extra investment for lines which are larger than necessary, or to escape the loss of needed carrying capacity because of lines which are too small.

In apparent recognition of the great variety of conditions to be dealt with, one of the popular natural gas handbooks* has devoted 45 pages to capacity tables for different diameters and lengths of pipe lines.

As a help to gas engineers in solving these problems, various formulas have been developed for determining the rate of flow of gas in pipe lines.

As early as 1893, a formula for determining the flow of natural gas under high pressures was worked out from tests made on the two 8-inch pipe lines conveying natural gas from the Indiana gas fields to Chicago.

As these lines were about 120 miles long, operated with around 500 pounds initial pressure, and were equipped with heavy screwed couplings, recessed for lead and carefully caulked and tested, the general conditions were very favorable for developing the useful working formula which follows:

$$Q = 2{,}968 \quad \frac{D^{2.6}}{10} \sqrt{\frac{P\,(P-P_1)}{L\,G}}$$

In which

Q = Amount of gas delivered per hour, in cubic feet.

D = Diameter of pipe in inches.

L = Length of pipe in feet.

P = Initial pressure in pounds per square feet.

P_1 = Terminal pressure in pounds per square feet.

G = Specific gravity compared with air.

2968 = Co-efficient of friction.

Formulas Developed

Since that early date, various gas engineers have developed a number of excellent gas flow formulas, and sliderules and computers, based thereon, have been designed for convenient use.

While the various methods of computing gas flow differ somewhat in details, they are all largely based upon the initial and terminal pressures, the length and diameter of pipe, the weight of gas and the co-efficient of friction in the pipe line.

The results thus obtainable come easily within 5 per cent, or better, of the actual gas flow, which is near enough for practical purposes.

Greater accuracy could hardly be expected when we consider the complications that come from leakage, river-crossings, drips, valves, fittings and bends in the line.

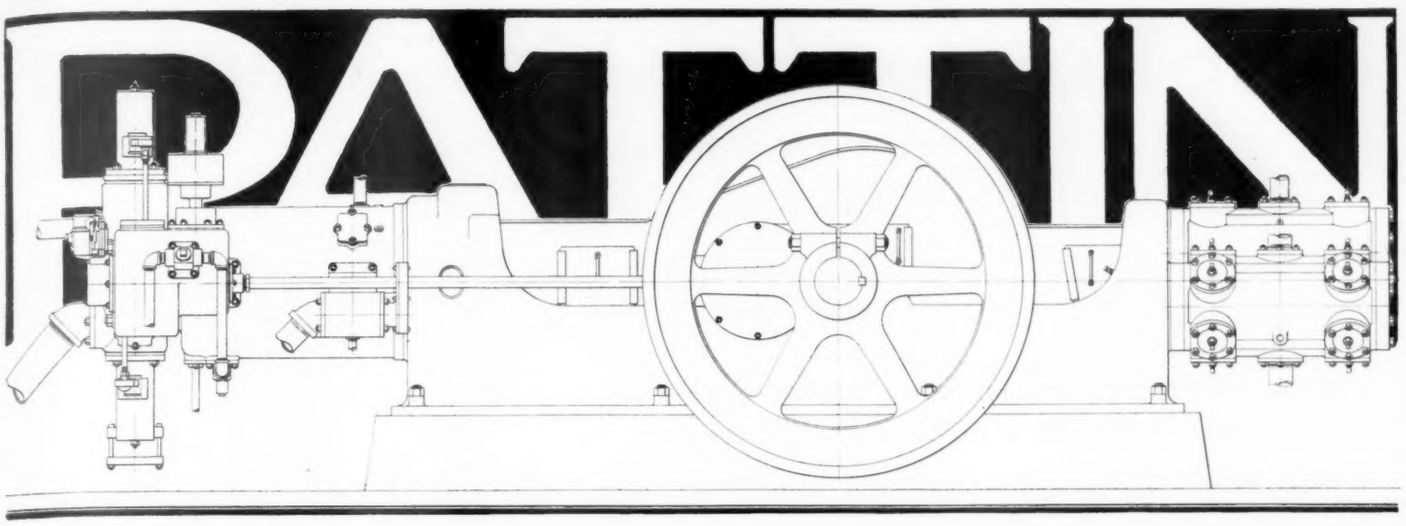
There is also the effect of variation in the composition and weight of gas from different wells and gas fields, and, in addition, commercial pipe as it comes from the mills is not uniform inside diameter or smoothness.

As the pressure of gas and length of lines so largely influence the amount of gas that can be transported, it becomes feasible to use compressing stations for raising the initial line pressure, or to install relay compressing stations at various points on a long pipe line, and by these methods materially increase the carrying capacity of the line.

Decision as to the proper course to pursue depends, in a measure, upon the relative costs of installing and operating the compressing stations, as compared with the cost of laying larger diameter pipe lines.

In consideration this question the probable length of life of the gas field is often an important factor.

*Handbook of Natural Gas, by Henry P. Westcott, Third Edition, 1920.



A NEW UNIT!

A Pattin Super-Power soon to be placed on the market

This is just a glimpse ahead, of another Pattin achievement.

In a future announcement complete information regarding this unit will be given, and when it will be available for delivery.

Watch for this announcement.

THE PATTIN BROS. CO.

In developing this new power unit, it has been our constant aim to build a unit that would overcome and remedy a trouble, common to the modern power. We have accomplished our purpose, and in so doing have produced a power far in advance of any heretofore offered. Here are some of the features.

Completely enclosed, combination splash and force feed lubrication.

High speed governor, gear driven, enclosed.

Automatic air starter.

Special mixer valve to run on air gas if necessary.

A special device, which takes practically all fire away from exhaust valve, making it possible to run for years without grinding valves.

Compressor cylinders mounted independently, making them accessible without changing a single connection, and fitted with Meister Patented Vanadium steel compressor valves.

Entire unit is self contained—no outside bearings.

Main bearings, renewable Phosphor Bronze, wedge adjustment.

THE PATTIN BROTHERS COMPANY

MARIETTA -:- -:- -:- OHIO

Manufacturers of

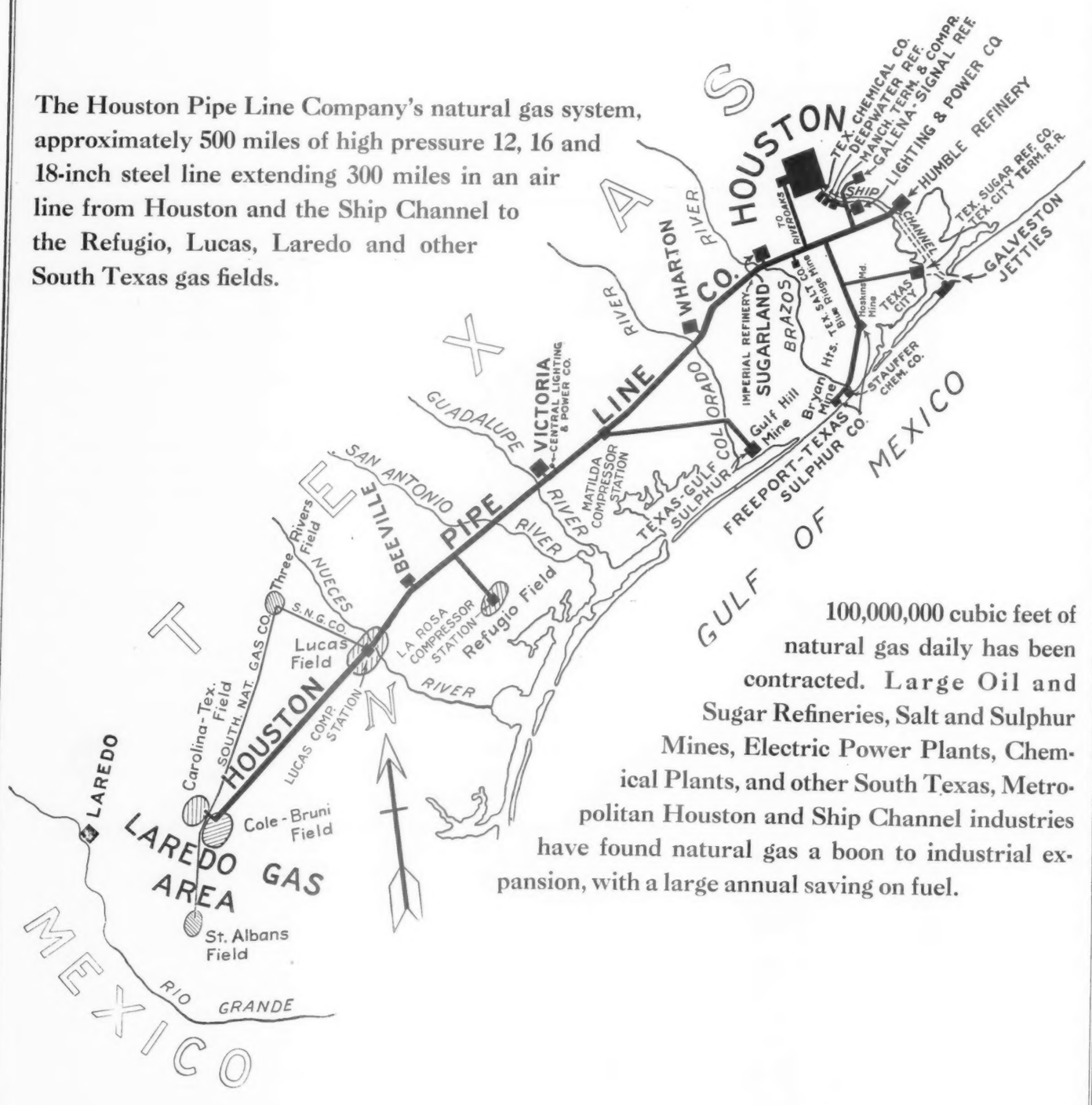
Gas Engines
Pumping Powers
Water Pumps
Vacuum Pumps
Air and Gas Compressors
Oil Country Boilers
Torpedo Reels and Clamps
Steel Storage Tanks
High Pressure Tanks
Howe Casing Heads
Shackle Irons

AGENTS—
TULSA, OKLA. A. S. Dunnington
NOWATA, OKLA. J. Barnes
WICHITA FALLS, TEX. J. W. Noland
PUTNAM, TEX. Putnam Supply Co.
BRADFORD, PA. Bradford Supply Co.

The Houston Pipe Line Company

Wholesale Distributors of Natural Gas

The Houston Pipe Line Company's natural gas system, approximately 500 miles of high pressure 12, 16 and 18-inch steel line extending 300 miles in an air line from Houston and the Ship Channel to the Refugio, Lucas, Laredo and other South Texas gas fields.



100,000,000 cubic feet of natural gas daily has been contracted. Large Oil and Sugar Refineries, Salt and Sulphur Mines, Electric Power Plants, Chemical Plants, and other South Texas, Metropolitan Houston and Ship Channel industries have found natural gas a boon to industrial expansion, with a large annual saving on fuel.

THE HOUSTON PIPE LINE COMPANY

HOUSTON -:- -:- -:- -:- -:- -:- -:- **TEXAS**

Chemical Composition of Natural Gas

Physical Properties Tabulated, Analyses Given, Specific Gravity Discussed; Compressibility, Viscosity Explained

By Dr. James B. Garner and Dr. R. W. Miller*
Hope and Affiliated Natural Gas Companies

Natural gas is, for the most part, composed of the hydrocarbons of the paraffin series, carbon dioxide, nitrogen, and helium. However, its composition varies considerably in the different fields. Natural gas of the eastern, or Appalachian Field, is almost entirely made up of the hydrocarbons of the paraffin series. Natural gas of some parts of Kansas, Oklahoma and Texas is very high in nitrogen and relatively high in helium content. Some of the natural gas of the Pacific Coast contains large percentages of carbon dioxide. Natural gas in a few districts contains hydrogen sulphide and organic compounds.

The paraffin hydrocarbons found in natural gas are methane, ethane, propane, butane, pentane, hexane, heptane, and oxtane. The first four named hydrocarbons are gaseous under ordinary conditions of temperature and pressure. The last four hydrocarbons are normally liquid at atmospheric temperature and pressure, and are the main components of natural gas gasoline. Methane is the predominating component of commercial natural gas and octane is the hydrocarbon which is present to the least extent.

The following is a tabulation of typical analyses of commercial natural gas:

Components	Pittsburgh	Cleveland	Cincinnati	Columbus	Bartlesville	Kansas City	Fort Worth	Los Angeles	Little Rock	Monroe
Methane	84.7	80.5	79.8	80.4	92.4	84.1	51.5	77.5	96.7	94.69
Ethane	13.7	18.2	19.5	18.1	3.1	5.7	10.2	16.0	....	2.80
Carbon Dioxide	....	....	....	....	1.4	0.8	....	6.5	1.0	0.2
Nitrogen	1.6	1.3	0.7	1.5	3.1	8.4	38.3	0.0	2.3	2.31

The data contained in this tabulation, with the exception of those relative to Monroe gas, have been taken from Technical Papers Nos. 109 and 158 of the United States Bureau of Mines. The information regarding Monroe gas has been furnished by J. A. Bechtold, Secretary, Standard Oil Co. of Louisiana.

Differentiation of "Dry" and "Wet" or "Casinghead" Natural Gas

Natural gas gasoline, as vapor, does not exist in recoverable quantities in natural gas. Stable natural gas gasoline is made up of the hydrocarbons butane, pentane, hexane heptane and octane. The notable instances of fields of natural gas production wherein gasoline vapors do not occur are: (a) Fort Smith, Ark.; (b) Shallow Sand, DeSoto Parish, Louisiana; (c) Elm Grove, La.; (d) East Texas; (e) Murraysville sand, Pennsylvania and (f) Upper Oriskany sand, Pennsylvania. (6,822 feet). The following analyses are of interest in this connection.

Components	Fort Smith (1)	DeSoto Parish (2)	Murraysville (1)	Upper Oriskany (3)	Elm Grove (4)	East Texas (4)
Methane	99.2	97.3	98.8	95.2	98.73	98.7
Ethane	....	....	....	2.4	....	....
Carbon Dioxide	0.2	0.4	....	0.1	0.15	0.1
Nitrogen	0.6	2.3	1.2	2.4	0.12	1.2

References:
1st. Analysis by George A. Burrell.
2nd. Technical Paper No. 109, United States Bureau of Mines.
3rd. Peoples Natural Gas Co.
4th. J. A. Bechtold, Secretary, Standard Oil Co. of Louisiana.

Natural gas is commonly described as "dry" and "wet" or "casinghead" gas. These descriptions are relative. "Dry" gas is usually produced from gas wells containing natural gas gasoline vapors, recoverable as liquid, to the extent of 0.75 gallon or less per 1,000 cubic feet, while "wet" or "casinghead" gas is natural gas which is produced from oil wells and contains gasoline vapors, recoverable as liquid, to the extent of more than 0.75 gallon per 1,000 cubic feet. There are well-known instances of gas coming from wells in which the gasoline content is more than 1 gallon per 1,000 cubic feet and there are many instances of gas coming from oil wells wherein the gasoline content is less than 0.25 gallon per 1,000 cubic feet.

Special Types of Natural Gas

Natural gas which contains any of the following substances are here arbitrarily classified as special types of natural gas; (a) hydrogen sulphide and organic sulphur compounds; (b) helium; (c) nitrogen in excess of 10 per cent by volume; (d) Carbon dioxide in excess of 10 per cent by volume; (e) vapors of carbon compounds, normally liquid, other than paraffin hydrocarbons.

Natural gas which contains hydrogen sulphide, or organic sulphur compounds, is produced at: (a) Glasgow, Ky.; (b) Olney, Ill.; (c) Findlay, Ohio. (d) From some wells near Monroe, La.; (e) Lower Oriskany sand, Pennsylvania, (7,740 feet); and (f) Gulf Coast and West Texas regions.

Natural gas which contains helium has been found in Kansas, Oklahoma, and Texas.

Natural gas which contains nitrogen in excess of 10 per cent by volume has been obtained in several counties in Kansas, and occurs in many wells in West Texas from the Panhandle on the north to Mitchell County on the south. The content of nitrogen is so high in some of the gas from the wells in West Texas that the gas is non-combustible.

Natural gas which contains carbon dioxide in excess of 10 per cent by volume is produced from a few wells in California.

The Knapp well in Terrebone Parish, Louisiana, is producing natural gas which forms a condensate in the line drips of the following properties: (a) gravity—32 degrees Baume; (b) color—straw; (c) boiling point range—374 degrees Fahrenheit to 410 degrees Fahrenheit; and (d) odor—like turpentine. This liquid is composed of naphthenes and hydroxylated carbon compounds which decompose on boiling.

The following tabulation of data is illustrative of the composition of these special types of natural gas:

Components	Glasgow	Olney	Lower Oriskany	Big Lake Texas	Dexter, Kans.	Eureka, Kans.	Iola, Kans.	Randall County Texas	McKittrick, Calif.	Section 31 Taft
Methane	23.6	37.5	98.8	....	14.85	51.80	79.10	14.69	66.2	67.40
"Ethane"	69.7	59.6	0.3	....	0.41	....	8.21	.....	1.0	8.00
Carbon Dioxide	....	....	....	....	.....	0.20	.....	Trace	30.4	24.60
Nitrogen	3.8	1.7	0.1	....	32.70	46.40	12.44	85.31	2.4	.....
Hydrogen Sulphide	2.9	1.2	0.8	7.0	....	....	....	.....	....	.....
Helium	....	....	....	.....	1.84	1.50	0.25	.....	....	.....
Oxygen	....	....	....	.....	0.20	0.10	.....	.....	....	.....

Water Vapor Content of Natural Gas

Manufactured gas is, for the most part, delivered from holders, near points of consumption, through low pressure mains to the public. The conditions of distribution are such that the gas is delivered to the consumer, practically saturated with water vapor. The pressure and temperature of distribution are determinative of the water vapor content of such gas. The standard reference books contain relatively complete information on this subject. Natural gas, on the other hand, is largely transported through underground pipe line systems, under high pressure to distant markets. The conditions of temperature and pressure are always those which result in delivery of the natural gas to the ultimate consumer wherein the natural gas is not saturated with water vapor. Problems in natural gas volume measurements always involve a knowledge of the water vapor content of the gas. This content may be determined by well-known physical and chemical methods. The standard reference books are, however, generally lacking, in information relative to the water vapor content of gas under pressures such as are employed in the transportation of natural gas to market.

The accompanying tabulation taken from "The Gas Works" may be of interest and value to the natural gas industry:

Proximate Gas Analysis—"Combustion" Method

Natural gas does not contain carbon monoxide, hydrogen, or the so-called "illuminants." The combustion method of analysis of natural gas is slightly different from that of manufactured gas on this account.

1. Apparatus

The most convenient, as well as the most accurate, type of gas analysis apparatus is that invented by Col. George A. Burrell, formerly of the United States Bureau of Mines. This apparatus consists of:

1. 100 c.c. gas burette graduated in tenths;
2. Four absorption pipettes; and
3. One combustion pipette, (all pipettes are connected by manifold).

All parts of the apparatus are conveniently arranged in reference to one another and are practically faultless in operation or manipulation. The apparatus can be purchased from practically any of the reliable chemical supply and apparatus companies.

2. Sampling

Sampling of gas properly is as an important a factor in the analysis of any gas as is the method of analysis or apparatus used. Proper containers, i.e., ones which do not leak, as well as proper method should be employed in collecting samples. If possible the sample of gas should be taken by the displacement of mercury. If mercury is not available the gas sample may be collected over water. However, before the collection of the sample by displacement of either mercury or water, the line delivering the

*The authors desire to express their appreciation for helpful suggestions and valuable assistance to: K. R. Kingsbury and Dr. Ralph A. Halloran of the Standard Oil Co. of California; Messrs. C. K. Clarke and J. A. Bechtold, of the Standard Oil Co. of Louisiana; and Messrs. W. S. Farish, Wallace E. Pratt, and Stewart P. Coleman of the Humble Oil & Refining Co.; and Miss Elizabeth P. Mackey of the Hope Construction & Refining Co.

PHYSICAL PROPERTIES—HYDROCARBONS OF NATURAL GAS—PARAFFIN SERIES

	Methane	Ethane	Propane	Butane	Pentane	Hexane	Heptane	Octane
Molecular formulas	CH_4	C_2H_6	C_3H_8	C_4H_{10}	C_5H_{12}	C_6H_{14}	C_7H_{16}	C_8H_{18}
Molecular weights	16.03 (5)	30.05 (5)	44.06 (5)	58.08 (5)	72.10 (5)	86.11 (5)	100.13 (5)	114.14 (5)
State-isolated at 60 degrees Fahrenheit and 30 inches mercury	Gas (1)	Gas (1)	Gas (1)	Gas (1)	Liquid (1)	Liquid (1)	Liquid (1)	Liquid (1)
Boiling points, degrees Fahrenheit	—263.2 (5)	—135.4 (5)	—49.0 (5)	33.1 (5)	97.7 (5)	156.2 (5)	208.4 (5)	257.9 (5)
Melting points, degrees Fahrenheit	—299.2 (5)	—277.6 (5)	—310.0 (5)	—211.0 (5)	—203.4 (5)	—137.7 (5)	—130.0 (5)	—69.7 (5)
Specific gravity—(air=1) at 60 degrees Fahrenheit	.5546 (1)	1.040 (1)	1.525 (6)	2.009 (1)	2.494 (5)	2.979 (5)	3.462 (5)	3.948 (5)
Specific gravity—(water=1) at 60 degrees Fahrenheit unless otherwise indicated	.....	.....	.....	0.6000 (1) at 32°F.	0.6258 (5)	0.6624 (5)	0.6874 (5)	0.7063 (5)
Cubic feet at 60 degrees Fahrenheit and 30 inches mercury, dry—per pound avoirdupois	23.60 (5)	12.59 (5)	8.58 (5)	6.515 (5)	5.248 (5)	4.394 (5)	3.780 (5)	3.316 (5)
Pounds avoirdupois per United States gallon at 60 degrees Fahrenheit unless otherwise indicated	.....	.....	.....	4.998 (5) at 32°F.	5.214 (5)	5.519 (5)	5.727 (5)	5.885 (5)
Cubic feet of vapor at 60 degrees Fahrenheit and 30 inches mercury—dry—in one United States gallon at 60 degrees Fahrenheit	.....	.....	.....	32.56 (5)	27.36 (5)	24.25 (5)	21.65 (5)	19.52 (5)
B.t.u. per cubic foot, gross heating value—dry—at 60 degrees Fahrenheit and 30 inches mercury	1009 (5)	1764 (5)	2519 (5)	3274 (5)	4029 (5)	4784 (5)	5540 (5)	6295 (5)
B.t.u. per pound, avoirdupois, gross heating value, at 60 degrees Fahrenheit	23,818 (5)	22,213 (5)	21,614 (5)	21,827 (5)	21,145 (5)	21,022 (5)	20,942 (5)	20,876 (5)
Critical temperature, degrees Fahrenheit	—139.9 (7)	93.2 (7)	206.6 (2)	303.4 (2)	392.8 (2)	454.1 (2)	512.6 (2)	565.5 (2)
Critical pressure—pounds absolute—per square inch	736.5 (7)	739.5 (7)	648.1 (2)	552.4 (2)	486.7 (2)	441.9 (2)	395.9 (2)	371.2 (2)
Specific heat at constant volume	0.449 (5)	.....	.....	0.530 (2)	0.512 (2)	0.527 (2)	0.504 (2)	0.505 (2)
Specific heat at constant pressure	0.593 (2)	0.413 (2)	.....	0.587 (2)	.....	.....	.....	.....
Ratio of specific heats	1.32 (2)	1.22 (2)	1.15 (2)	1.108 (2)	.....	.....	.....	.....

(1) Beilstein's Organische Chemie. (2) Landolt's Tabellen. (3) United States Bureau of Standards Circular No. 57. (4) "Gasoline Industry," by G. A. Burrell. (5) Calculated. (6) Gas Chemists Hand Hook. (7) Kaye and Laby—Physical and Chemical Constants.

NOTE: In the calculations, the following equivalents were used: 1 pound avoirdupois=453.59 grams, 1 United States gallon=3.7853 liters, 1 cubic foot=28.317 liters, 1 atmosphere=14.73 pounds per square inch.
Molecular weight, in pounds avoirdupois, of any gas or vapor, will occupy a volume of 378.4 cubic feet at 60 degrees Fahrenheit and 30 inches mercury—dry.
Baume modulus=140.

gas should have a rapid stream of gas delivered through it so as to insure complete removal of air. The importance of proper and correct methods of sampling is often overlooked and, as a consequence, of not using care, inaccurate conclusions are drawn regarding not only the composition of the gas, but also its specific gravity, heating value, etc.

3. Procedure

Before proceeding with the analysis of any sample of gas, the analyst should examine the apparatus carefully to assure himself that it is in such condition that a correct analysis can be made. The mercury used in the apparatus should always be perfectly clean, for if it is in any other condition it will adhere to the sides of the burette and thus incorrect readings will be taken. It often happens that the mercury becomes contaminated with stopcock grease, or by sulphur compounds contained in the gas sample. If the mercury is not clean, it should be filtered through a 10 per cent solution of sodium hydroxide, then washed several times with distilled water, and finally filtered through a 25 per cent solution of nitric acid.

The gas burette and combustion pipette, if not clean, should be put in proper condition by the use of a mixture of concentrated sulphuric acid and posassium or sodium dichromate, then washed with distilled water and dried.

All stopcocks should be greased, but an excess of grease should be avoided as this may cause an obstruction to the flow of gas in the capillary tube of the manifold.

After it has been found that the mercury, burette, combustion pipette, and stopcocks are in proper condition, confirmation of this condition should be made by making a positive test. This is done by expelling the air from the gas burette, then producing a partial vacuum on the manifold by lowering the level of the mercury to the 50 c.c. mark on the gas burette. The reading is then taken and if the volume is the same after five minutes the level of the mercury is then lowered to the 80 c.c. mark on the burette. If there is no change in the volume after five minutes the apparatus may be assumed to be leakproof.

Before transferring the gas sample to the burette for analysis, a sample of air should be drawn into the burette. The oxygen should be extracted from this by passing the air into the alkaline pyrogallol solution until the volume is the same after two successive treatments of the air with this solution. The residual gas is nitrogen. All the pipettes, the manifold, and the manometer should be washed at least two times with this sample of nitrogen. In transferring the gas to be analyzed to the burette, a small capillary glass tube, the bore of which is not greater than 1 millimeter, is connected to the sampling tube and the burette by short pieces of thick-walled rubber tubing. (The rubber tubing must be cleaned prior to use with caustic soda solution and water.) The length of the rubber tubing should be such that there will be as little as possible of the rubber tubing exposed to the gas. Rubber adsorbs heavy hydrocarbons from gas rich in these components. The gas should be displaced from the container preferably by mercury, as water always contains a small amount of dissolved air. The burette and manifold should be washed several times with the gas before taking the sample to be used for the analysis. The temperature of the water jacket and the barometric reading should be taken and recorded after each reading in the gas burette.

Method of Procedure

A sample of 85 c.c. should be taken for the analysis. This sample should be allowed to remain in the burette until the volume is constant for three minutes, before it is measured against the mercury in the manometer at atmospheric pressure. The volume in the burette is measured at atmospheric pressure and is recorded as **the original** volume (A). The gas is then passed several times into the pipette containing potassium hydroxide solution, each time leaving the gas in contact with the solution for a period of two minutes. The volume of the residual gas must be constant after two consecutive readings before the total content of carbon dioxide has been removed. Record this volume as (B). (If the gas contains hydrogen sulphide, this gas will be absorbed by the potassium hydroxide. All gas samples should be tested beforehand with silver nitrate and lead acetate solution to detect the presence of this substance.) When it has been shown that the carbon dioxide content has been removed from the gas, the difference between the original volume (A) and the resultant volume (B) is equal to the volume of carbon dioxide contained in the gas (hydrogen sulphide not being present).

The resultant gas (B), after carbon dioxide has been removed, is delivered to the fuming sulphuric acid pipette and permitted to remain in it for three minutes. The residual gas with some sulphur trioxide in it is then passed into the potassium hydroxide solution for the removal of the sulphur trioxide content and the volume of the residual gas is then measured in the gas burette. This procedure is repeated until the volume of the residual gas (C) is constant after two consecutive readings. The difference in volume, of the gas before (B) and after treatment with fuming sulphuric acid (C) is recorded as the "propane and higher hydrocarbon" content of the gas.

The resultant gas (c) is passed from the burette into the pipette containing alkaline pyrogallol solution. (Care must be taken to use only a solution of alkaline pyrogallol which has been freshly prepared and of the proper concentration.) The gas and solution are permitted to remain in contact with one another for a period of five minutes. The gas and solution must be brought into contact a sufficient number of times until two consecutive readings are the same. Record this as volume (D). The difference between volumes (C) and (D) is due to oxygen. The residual gas (D) is transferred from the burette to the pyrogallol pipette for storage and subsequent use.

A sample of pure oxygen (about 80 c.c.) is collected in the burette and its volume carefully determined at atmospheric pressure. (Volume 1.) The sample of oxygen (1) is then delivered into the combustion pipette by the displacement of mercury. About 20 c.c. of the residual gas is withdrawn from the pyrogallol pipette, and its volume accurately determined (J). The sample of gas (J) is then slowly delivered into the combustion pipette and the mixture burned. The gas and apparatus are permitted to cool to room temperature and the resultant volume measured (L). Record the first contraction in the volume (M) of the gas, i. e., (J-1)—L=M and then pass the gaseous mixture resulting into the potassium hydroxide pipette. After three minutes contact of it with the solution contained therein, the volume of gas is again measured (N). The loss in volume (L-N) is due to "first" carbon dioxide. Another sample of pure oxygen (about 35 c.c.) is collected in the burette and its volume carefully determined at atmospheric pressure (Volume O). The sample of oxygen (O) is then delivered into the combustion pipette by the displacement of mercury. The residual gas is delivered the second time into the combustion pipette and burned, and the same procedure followed as before until the volumes are constant after two successive treatments in the combustion and potassium hydroxide pipettes. The "several" contractions in volume and the "several" carbon dioxides are recorded.

The above data are utilized in the following manner for the calculation of analytical results:

1. Volumetric Composition

(a) The percentage of carbon dioxide, "propane and higher hydrocarbon," and oxygen are calculated by dividing the contraction in volume, due to each of these substances, by the volume of the original sample used (A) and multiplying the quotient by 100.

(b) The percentage of ethane and methane are calculated as follows: 1. The quantity—(two times the total number of cc.'s of carbon dioxide produced by combustion less the total contraction in co.'s during combustion.) divided by 1.5 equals cubic centimeters of ethane; this volume of ethane divided by volume (J) and this quotient multiplied by 100 equals percentage of ethane.

2. The total number of co.'s of carbon dioxide produced by combustion less twice the volume of ethane thus determined equals the number of cubic centimeters of methane contained in volume (J). This quantity divided by volume (J) and the quotient multiplied by 100 equals the percentage of methane.

(c) The percentage of nitrogen is calculated by subtracting from 100 the sum of the percentage of all the other substances.

2. Heating Value of the Gas

The gross heating value of the gas per cubic foot at 60 degrees Fahrenheit, and 30 inches of mercury—dry—is calculated by multiplying the percentage of each combustible substance in the gas by its heating value and summing up the products thus obtained.

Table of Heating Values per Cubic Foot

Methane	—1009
"Ethane"	—1764
"Propane and Higher Hydrocarbons"	—2519

3. Specific Gravity of Gas

The specific gravity of the gas at 60 degrees Fahrenheit and 30 inches of mercury—dry—is calculated by multiplying the percentage of each of the substances by the specific gravity of the gas and then summing up the products thus obtained.

Table of Specific Gravities

	Air=1
Oxygen	1.1055
Nitrogen	0.9674
Carbon Dioxide	1.5291
Methane	0.5546
Ethane	1.0409
Propane	1.5250

Directions for Making up Potassium Hydroxide Solution

Dissolve one part of potassium hydroxide (by weight) in three parts of distilled water. Potassium hydroxide not purified by alcohol should be used. About 140 c.c. of this solution is required for the ordinary Burrell pipette. If placed in a tightly stoppered bottle, this solution will keep indefinitely. It should be allowed to cool before placing it in the pipette.

Directions for Making up Alkaline Pyrogallol Solution

(a) Dissolve one part of potassium hydroxide (by weight) in two parts of distilled water. After cooling, mix with an equal volume of—

(b) Dissolve one part of pyrogallic acid (by weight) in three parts of distilled water. About 140 c.c. of this mixture of (a) and (b) required for the ordinary Burrell pipette. Potassium hydroxide not purified by alcohol should be used. Fill the pipette or bottle immediately after mixing. If placed in a tightly stoppered bottle, this solution will keep indefinitely.

Filling the Pipettes

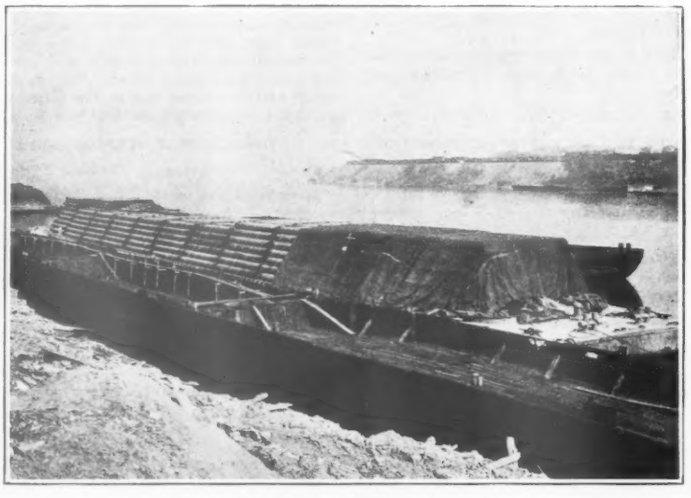
Insert a small funnel into the opening of the reservoir of the pipette and pour in about 140 c.c. of the solution to be used. There should be enough solution in the pipette to completely fill the ab-

AQUEOUS VAPOR IN SATURATED GAS AT VARIOUS TEMPERATURES AND PRESSURES EXPRESSED IN GALLONS OF WATER PER MILLION CUBIC FEET OF FREE GAS CORRECTED TO 60° FAHRENHEIT AND 30" MERCURY

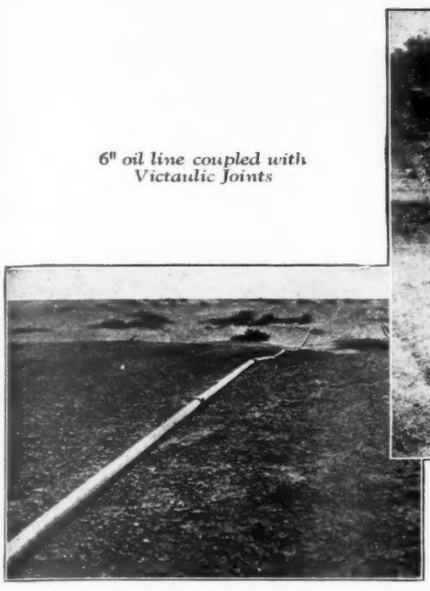
Temp. Fahr.	Abso. Temp.	Pressure of Aque. Vapor Inches Mercury	Gauge Pressure in lbs. per sq. inch 0	1	2	3	4	5	6	7	8	9	10	12	15	20	25	30	35	40	45	50
			Absolute Pressure in inches of mercury 29.92	31.96	33.99	36.03	38.06	40.10	42.14	44.17	46.21	48.24	50.28	54.35	60.46	70.64	80.82	91.00	101.18	111.36	121.54	131.72
32°	492	0.18	29	27	25	24	23	22	21	20	19	18	17	16	14	12	10½	9½	8½	7½	7	6½
35°	495	0.20	32	30	28	27	25	24	23	22	21	20	19	18	16	13½	12	10½	9½	8½	8	7½
40°	500	0.25	40	38	35	33	32	30	29	27	26	25	24	22	20	17	15	13	12	11	10	9
45°	505	0.30	48	45	42	40	38	36	34	33	31	30	29	27	24	20	18	16	14	13	12	11
50°	510	0.36	58	54	51	48	46	43	41	39	37	36	34	32	29	24	21	19	17	15½	14	13
55°	515	0.43	70	65	61	58	55	52	49	47	45	43	41	38	34	29	26	23	20	18½	17	15½
60°	520	0.52	84	79	74	70	66	63	60	57	54	52	50	46	42	35	31	27	25	22	20	18
62°	522	0.56	91	85	80	75	71	68	64	61	59	56	54	50	45	38	33	30	27	24	22	20
65°	525	0.62	101	95	88	84	79	75	71	68	65	62	60	55	50	42	37	33	30	27	25	23
70°	530	0.73	119	112	105	99	93	89	84	80	77	73	70	65	58	50	43	39	35	31	29	27
75°	535	0.87	143	134	125	118	112	106	101	96	92	88	84	78	70	60	52	46	42	38	35	32
80°	540	1.02	169	157	148	139	131	125	118	113	108	103	99	91	82	70	61	54	49	44	40	37
85°	545	1.20	200	186	175	165	155	147	140	133	127	122	117	108	97	83	72	64	57	52	48	44
90°	550	1.41	236	220	207	194	184	174	165	157	150	144	138	127	114	97	85	75	67	61	56	52
95°	555	1.65	279	260	244	229	216	205	195	185	177	169	162	150	134	114	100	88	79	72	66	61
100°	560	1.92	327	306	286	269	254	240	228	217	207	198	190	175	157	133	116	103	92	84	77	71
212°	672	29.92																				

The data contained in the above tabulation were compiled as a result of experiments by members of the British Gas Association. The "gallons" referred to are Imperial gallons (1 Imperial gallon=1.2 United States gallons.)

PIPE FOR NATURAL GAS LINE READY FOR SHIPMENT

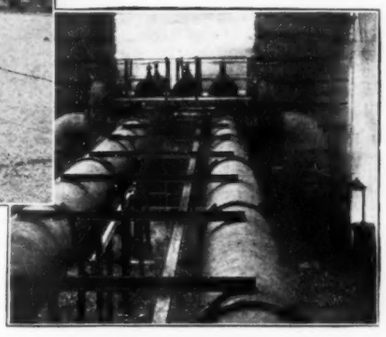


Barge at Pittsburgh loaded with 20-inch pipe which is ready for its 2,000-mile journey to a Louisiana grave.



6" oil line coupled with Victaulic Joints

Laying Chestnut-Smith Corporation Natural Gas line tapping Parson Pool Ranger Field, Texas. Five men made up 500 Victaulic Joints a day.



24" gas main coupled with Victaulic Joints

A joint a minute but no leaks —With VICTAULIC JOINTS

For detailed information and list of uses and users, write for Victaulic Bulletin, No. 1

THREE miles of second hand pipe was used. It was laid over hills and across ravines. The gas pressure at the inlet was 400 pounds. Not a whiff of gas was lost at any of the 825 Victaulic Joints. The line was absolutely gas-tight from end to end.

A gang of five men fitted these Victaulic Joints at the rate of 500 joints a day—easily twice as many joints as a six-man gang could make with threaded pipe and couplings.

Victaulic Joints not only cut down the time and labor cost of every mile of pipe laid, they also *cut out the cost for special flexible joints, expansion joints and expansion bends.* Every Victaulic Joint is a straight coupling, flexible joint and expansion joint—*an all-purpose joint for every joint on the line.*

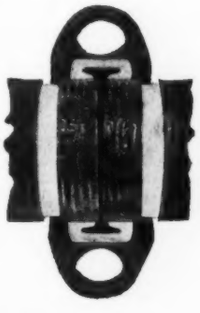
Victaulic Joints set new standards for ease, speed and economy on pipe installations over rough ground or in curving trenches. No accurate grading is needed, for the pipe does not have to be in exact alignment to make up the joint. Pipes up to 12" diameter can be easily coupled by unskilled labor at the rate of a joint in two minutes.

Vibration or ground movement does not affect shock-absorbing, permanently leak-tight Victaulic Joints.

Thousands of Victaulic Joints are in service on natural and manufactured gas lines, on oil lines, water lines, sewage lines, on compressed air lines and vacuum systems.

Victaulic Joints are leak-proof at all pressures from vacuum to over two tons pressure per square inch.

They are supplied for all sizes from ¾" up—for steel, wrought iron or cast iron pipes.



VICTAULIC COMPANY OF AMERICA
26 Broadway New York

Texas, Mid-Continent and California Representatives
SMITH SEPARATOR COMPANY
Tulsa Okla.

The all-purpose pipe joint

VICTAULIC

REG. U. S. PAT. OFF

"For every joint on the line"

Flexible Leaktite Pipe Joints

FOR GAS, OIL, WATER, SEWAGE, COMPRESSED AIR, ETC.

sorption bulb and connecting tube, thereto, and enough surplus to allow for 10 c.c. in the reservoir. If too much solution is put into the pipette, the reservoir will overflow when the gas sample is passed into the absorption pipette.

Determination of Hydrogen Sulphide and Organic Sulphur Compounds in Natural Gas

Hydrogen sulphide has been found to exist in various supplies of natural gas. Usually, it is necessary to remove it before the gas can be sold to domestic consumers. Hydrogen sulphide has an objectionable odor, and in addition to this, when burned produces sulphurous and sulphuric acids with the water vapor formed by the combustion of the natural gas hydrocarbons. For these reasons, a qualitative test should be run on all natural gas from new sources to ascertain if hydrogen sulphide is present. If this test is positive, a quantitative test is necessary to ascertain its amount. The quantity is usually expressed in grains per 100 cubic feet of the natural gas tested.—See "Standards for Gas Service," Circular No. 32, Bureau of Standards.

The following are practically the standard methods of tests for hydrogen sulphide:—(a) Qualitative Test.

To determine the presence or absence of hydrogen sulphide in natural gas, it is only necessary to bubble a slow stream of the gas through a 5 per cent aqueous solution of lead acetate. The solution may conveniently be contained within a test tube or a graduated cylinder, and the gas to be tested can be delivered from a small valve on the supply line with the solution by means of a short length of rubber tubing. If hydrogen sulphide is present in the natural gas tested, a black precipitate of lead sulphide will be formed. The lead acetate solution will remain colorless, if hydrogen sulphide is absent.

An adaptation of this same test, consists of moistening white filter paper with the solution of lead acetate and allowing the stream of gas to impinge upon the paper. Hydrogen sulphide in the natural gas will color the filter paper dark, or even black. This lead acetate test is purely a qualitative one, and gives no indication of the amount of hydrogen sulphide carried in the natural gas.

(b) Quantitative Test

By the use of a Tutwiler burette, it is possible to determine quite rapidly and accurately the amount of hydrogen sulphide in a natural gas. For details of apparatus and methods of procedure in analyzing natural gas quantitatively for hydrogen sulphide, reference is made to Gas Chemists Hand Book, Second Edition, 1922, pages 332 to 335, inclusive.

In addition to a content of hydrogen sulphide, some samples of natural gas contain vapors of organic sulphur compounds. Again, there are samples of natural gas which do not have a content of hydrogen sulphide, but do contain vapors of organic sulphur compounds. The presence of organic sulphur compounds in natural gas may be proven by subjecting the gas to the test for "total sulphur" in accordance with apparatus and methods of procedure as described in Gas Chemists Hand Book, Second Edition, 1922, pages 339 to 342, inclusive, and in Circular No. 48, Bureau of Standards, pages 129 to 146. Natural gas gasoline which is recovered from natural gas containing hydrogen sulphide and organic sulphur compounds reacts "positive" to the doctor and corrosion test, methods 520.3 and 530.1 Technical Paper 323 A, Bureau of Mines.

Specific Heats of Natural Gas

One of the most constant of the physical properties of natural gas, or its components is known scientifically as specific heat. This property may be of considerable importance in subsequent studies on gas measurement problems. It is therefore on account of this possible utility of knowledge regarding specific heats of gases that this theme is presented.

The specific heat of gas is of two kinds: (1) specific heat at constant volume; and (2) specific heat at constant pressure.

When heat is communicated to gas, the volume of gas being constant, this heat may be utilized: (a) In increasing the temperature of the gas; and (b) in increasing the relative motion of the atoms making up the molecules of the gas.

When the gas is heated at constant pressure, additional energy to that specified above is required to perform external work or the gas expands. The specific heat of a gas at constant pressure is always greater than the specific heat of the same gas at constant volume. The relationship of one specific heat to the other is known as the ratio of specific heats. $\left(\frac{Cp}{Cv} = V\right)$ This ratio is highest with gas of the simplest composition and has a maximum value of 1.66 and the ratio is lowest with gases of the most conflex composition and has a minimum value approaching one.

The specific heat of natural gas at constant pressure (Cp) may be defined as the number of British Thermal units which are required to raise 1 pound of gas from 60 degrees Fahrenheit to 61 degrees Fahrenheit a constant pressure. The specific heat of natural gas at constant volume (Cv) may be defined as the number of British thermal units required to raise one pound of gas from 60 degrees Fahrenheit to 61 degrees Fahrenheit at constant volume.

The determination of the specific heats of gases, or their ratio, is a matter which requires first class equipment and technical skill.

The standard reference books contain data on the specific heats of some of the components of natural gas. The specific heat of the mixture is additive of the partial specific heats of the component gases. If the percentage-volume-composition of any sample of natural gas is known, the specific heat at constant pressure, or at constant volume, of this sample of natural gas may be calculated by multiplying the known specific heats of the components by the percentage compositions and by adding the products thus obtained.

If the reader is interested in a more complete discussion of the subject of specific heats of gases, reference is made to Edser's test-book—"Heat" and Luke's test-book "Engineering Thermodynamics."

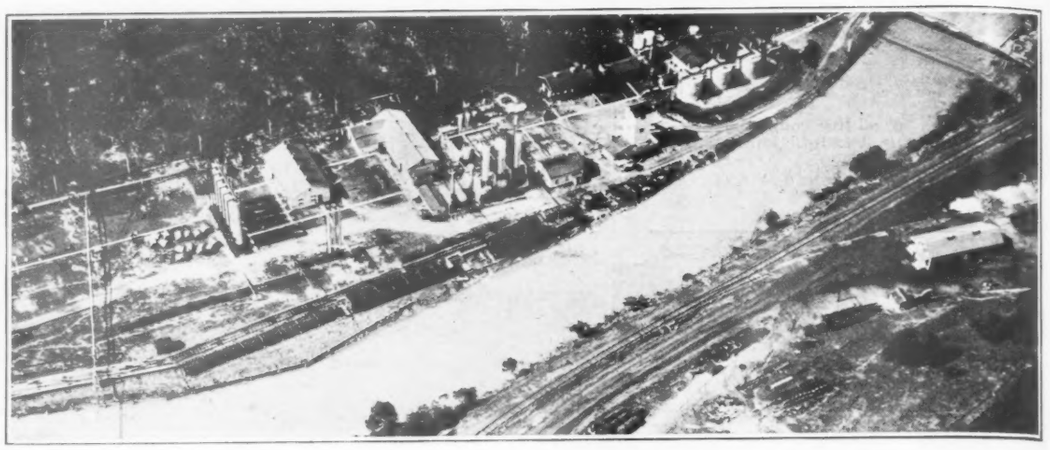
Compressibility of Natural Gas

The volume of any gas is sensitive to changes of pressure. According to Boyle's law, the volume of gas, kept at one uniform temperature, varies inversely as the pressure. This law was formulated as a result of a study of Boyle covering charges in volumes over a pressure range varying from 3 centimeters to 300 centimeters of mercury. It has been found by experiment, that this law applies only to fixed gases in their volume-pressure relations of a very narrow range. The product of pressure and volume (Pv) is constant only within this range. (1) "With small pressures, outside of this range, the product, Pv, decreases with increasing pressure showing that the contraction with increasing pressure is less than is described by Boyle's law; (2) with large pressures, outside of this range, the product, Pv, increases with increasing pressure showing that the contraction with increasing pressure is greater than is described by Boyle's law; and (3) All gases, in consequence, show a minimum value for the product Pv. The pressure corresponding with the minimum depends on the nature of the gas and on the temperature. The minimum is less prominent with the more permanent, or fixed, gases than with the more condensible gases, or vapors."

Natural gas is not a fixed, or permanent, gas but is composed of hydrocarbon gases, which, when subjected to pressure show deviations from the volume-pressure relations which one would calculate from Boyle's law. Such deviations, as have been noted by experimenters in their studies of the deportment of natural gas, or any of its components from the view point of Boyle's law, are known as compressibility factors. The magnitude of these factors, in the case of natural gas, depends not only upon the pressure but also the nature of the components of the gas. Generally speaking; commercial natural gas does not show a deviation of any consequence at the pressures employed in large distributing systems. However, a large proportion of commercial natural gas, which is transported under high pressure, is of such composition that the magnitude of the compressibility factors is such that the industry may find it well to consider its significance. Technical Paper No. 158, of the Bureau of Mines, by G. A. Burrell and I. W. Robertson contains results of a study of the compressibility of natural gas from 31 cities in the United States.

The following interesting figure is taken from this Technical Paper:

NATURAL GASOLINE PLANT IN WEST VIRGINIA



The airplane looks down on the plant which helps materially in providing fuel for it and for the entire motor industry.

A set of correction factors for deviations of gas from Boyle's law has been prepared by P. M. Biddison and may be found in "Natural Gas," 1923, June, page 30. The use of these factors depends upon a knowledge of the chemical composition of the natural gas in question.

A very practical method of determining the deviation, or compressibility factors, for natural gas is outlined in "Natural Gas," 1921, August issue. This method has been carefully worked out by the engineering department of the Standard Oil Co. of California.

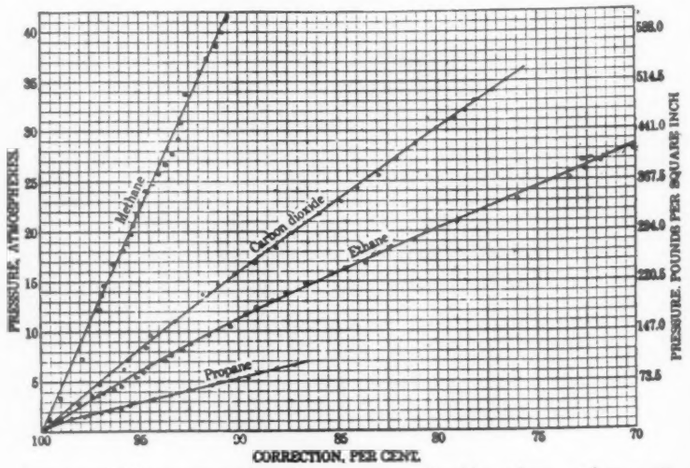
Particular attention is directed to the study conducted by G. A. Burrell and G. W. Jones, United States Bureau of Mines, Reports of Investigations, Serial No. 2.276, entitled "Pressure-Volume Deviation of Methane, Ethane, Propane, and Carbon Dioxide, at Elevated Pressures."

Specific Gravity of Gas

The measurement of large volumes of natural gas, under high pressure, by means of orifice meters, is a practice which has as one of its fundamentals, a knowledge of the specific gravity of gas.

The term, specific gravity, means the ratio of a weight of a given volume of gas to a weight of an equal volume of dry air, free from carbon dioxide, measured at the same temperature and pressure. Unless it is otherwise expressly agreed, it is understood that the specific gravity of air is 1.0000 at a temperature of 60 degrees Fahrenheit and under a pressure equivalent to that of 30 inches of mercury at 32 degrees Fahrenheit.

Three methods of determining the specific gravity of gas are more or less generally used in the national gas industry: (a) the effusion method; (b) the specific gravity balance, and (c) the



Compressibility curves of methane, carbon dioxide, ethane and propane.

method based upon calculations from results of accurate gas analysis.

Effusion Method

The construction of the effusion apparatus is well known to men in the natural gas industry.

The simplest method of determining the specific gravity of natural gas, for control and ordinary laboratory purposes, is that made possible by the use of the improved Schilling apparatus. The readiness and speed with which the determination can be carried out are factors which have very largely contributed to the widespread use of this method.

According to this method, use is made of Graham's law of diffusion: "The relative speeds of diffusion of gases are inversely proportional to the square roots of their relative densities, or specific gravities." By speed of diffusion is meant the time in seconds which is required for a fixed quantity of gas to pass through a small opening, or orifice. Specific gravities are therefore proportional to the squares, of the times of effusion of gas and air. By determining the times of effusion of equal volumes of natural gas and air, under the same temperature and pressure, through the same orifice, the specific gravity of natural gas may be calculated as follows:

$$\text{Specifiv gravity} = \frac{t^2 \text{ (gas)}}{t^2 \text{ (air)}}$$

t—Time in seconds as measured by a stop watch.

Schilling Apparatus

The Schilling apparatus consists of a glass jar, approximately 3.5 inches in diameter by 12 inches tall, with an enlarged base. A brass plate is cemented on the jar at the top. The brass plate carries an armored glass tube which screws into position on the plate above the jar. At its upper end, this tube carries a three-way stopcock into which fits a small, well protected, glass tip. A small platinum disc, with orifice made in the center thereof, is sealed into the glass tip. The inner glass tube is graduated so that the volumes of natural gas and air may be closely observed.

The procedure in conducting a specific gravity determination by means of the Schilling apparatus is fully described in the following publications: (a) Gas Chemists Handbook, Page 208; (b) White's Gas and Fuel Analysis, Page 181, and (c) in circular of the American Meter Co., entitled "Specific Gravity Apparatus."

The following statement relative to the effusion method has been taken from Circular No. 48, Bureau of Standards, entitled "Standard Methods of Gas Testing," Pages 178 and 179:

"The effusion process, as it occurs in the various forms of apparatus now in use, is not so simple as indicated by the square root relation. Quite a number of factors other than the density of the gases affect the relative rates of effusion. Of these may be mentioned thickness of orifice plate and size and shape of orifice, the pressure under which the gas effuses, the ratio of the specific heats, the viscosity of the gas, etc. The quantitative effect of several of these factors has not been determined as yet.

"The character of the orifice used is a factor of prime importance. The plate in which it is made (usually platinum) should be as thin as practicable; platinum-iridium as thin as 0.02mm can be used for this purpose. The orifice should be smooth and round without any projecting burr. The orifice should be as large as possible, giving consideration to the time of outflow necessary for the required accuracy of timing.

"When water is used as the confining liquid in the effusion apparatus, considerable care must be exercised to eliminate, so far as possible, the error due to condensation of moisture in the orifice. Condensation is indicated by a decreasing rate of effusion as shown by an increase in successive times. This may be a serious source of error and should be guarded against by passing dry air or gas through the orifice before use as often as may be necessary. The orifice should never be dried by heating over a flame. The trouble due to condensation of moisture in the orifice is eliminated in those forms of apparatus which use mercury as a confining liquid.

Importance of Pressure

"It is important that the apparatus should always be operated with the same pressures at start and finish of the timing. The excess of pressure above atmospheric at the end of the time interval taken should not be less than 2 inches water pressure; preferably it should be somewhat greater. The initial pressure should not be too high, generally not over 20 inches of water pressure should be allowed.

"In filling the apparatus with gas, it is essential that the method employed be such as to introduce a sample uncontaminated by air. It is probably better to fill the apparatus with gas which is practically at the temperature of the apparatus and which has been saturated with water vapor previous to its introduction into the apparatus, unless the gas is being measured dry or partially saturated in an apparatus using mercury. When the orifice tube is filled with air at the beginning of a run, the timing should not be begun until sufficient gas has passed through to sweep out all of this air.

For a specific gravity determination, several consecutive runs should be made on both gas and air. With a time interval less than 2 minutes, it is probably necessary to secure three or four intervals which agree within one-half of 1 per cent before the average can be considered as satisfactory. Any series of results in which the effusion time is constantly changing in one direction should be discarded.

"In order to determine the degree of accuracy secured with any instrument under certain operating conditions, it is necessary to compare the results so obtained with the density of the same gas determined by an accurate weighing method. Apparatus calibrated in this manner may be used with some degree of satisfaction provided the physical properties of the gases tested do not differ greatly from those of the gas with which the calibration was made."

The Schilling apparatus is essentially a field instrument, when it is used by a careful operator and is properly maintained and inspected. One of the large eastern natural gas producing companies has used calibrated instruments of this type for its specific gravity determinations. All of the instruments thus used were carefully calibrated in the laboratory against the Edwards specific gravity balance, using a gas of approximately the same specific gravity for standardization, as the gas to be tested. Only those orifices were used, which carried very small correction factors. The instruments in field use were regularly inspected and checked in the laboratory for their accuracy. The following results, taken from one series of control tests, may be of interest in this connection:

Instrument Number	Tip Number	Specific Gravity by Instrument	True Specific Gravity	Correction
N	A	0.5643	0.6219	+0.0576
O	28	0.6122	0.6219	+0.0097
11	B	0.6144	0.6219	+0.0075
49	X	0.6031	0.6219	+0.0188
20	26	0.6018	0.6219	+0.0201
44	8	0.6175	0.6219	+0.0044
43	23	0.5866	0.6219	+0.0353
30	1	0.6071	0.6219	+0.0148
37	C	0.5924	0.6219	+0.0295
4	D	0.5732	0.6219	+0.0487
K	E	0.5617	0.6219	+0.0602

Of the 11 instruments tested only three were regarded as suited for field work. The instruments referred to are those numbered O, 11 and 44, of which the correction factors were +0.0097, +0.0075 and +0.0044.

It has been found as a result of careful checks that effusion instruments used under such restrictions give most dependable results. The results thus obtained are reproducible on the Edwards balance and by calculation from results of chemical analysis.

Specific Gravity Balance Method

This method is regarded as precise and accurate in the determination of specific gravity of natural gas for scientific and technical purposes. The apparatus employed is of such nature that the highest possible accuracy can be attained only when its several parts are kept in first-class condition and when operated under the most favorable circumstances. The treatment accorded the balance and the skill employed in its operation will determine largely the accuracy obtained in its use. The Edwards balance is essentially an appliance for use under other conditions than those which usually prevail in the field. Highly satisfactory results are obtainable in the use of the Edwards balance for the determination of specific gravities of natural gas, samples of which have been carefully taken in proper containers in the field and delivered to the laboratory for test.

It is of importance, however, to note, at this point, that specific gravities which have been calculated from results of accurate gas analysis are uniformly in very close agreement with specific gravities determined by means of the Edwards balance. The authors feel that both methods of procedure are dependable and accurate for all gas measurement purposes.

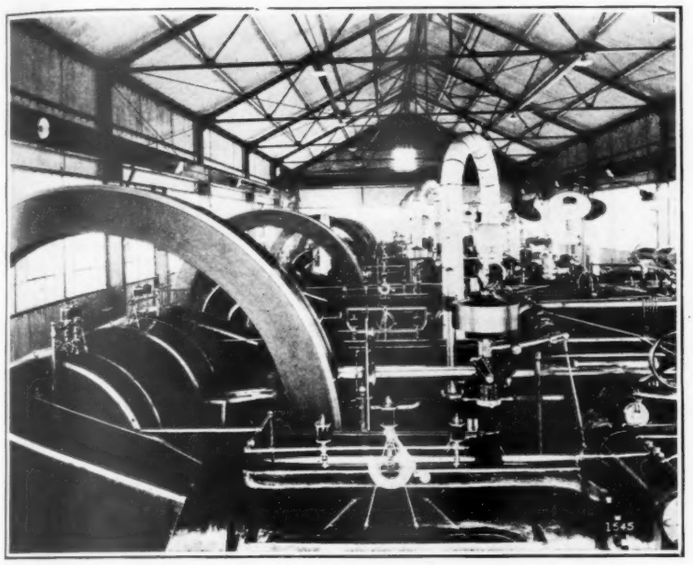
Circular No. 89 of the Bureau of Standards entitled "A Specific Gravity Balance for Gases" by J. D. Edwards contains a complete statement of: (a) principle of method; (b) description of apparatus; (c) operating directions; (d) source of error in use of the balance; and (e) accuracy of method.

Methods Based Upon Calculations From Results of Accurate Gas Analysis

Elsewhere in this issue, two methods of natural gas analysis have been described: (a) Proximate methods of gas analysis; and (b) analysis by fractionation at low temperature. Results of analysis conducted according to either of these two methods can be used most safely for the calculations of specific gravity of gas. It is generally accepted that the specific gravity of a mixture of gas under standard conditions of temperature and pressure is the sum of the partial specific gravities of its components.

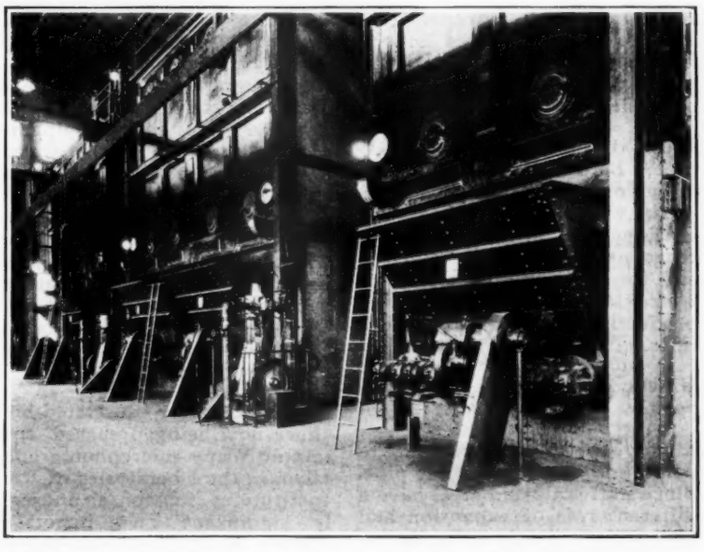
The matter of the determination of specific gravity of natural gas is of first importance in the natural gas industry, and it is to be hoped that subsequent investigation will result in development of apparatus and method which will give the industry a dependable source of information of specific gravity of natural gas under pressures which simulate those obtaining in the pipe lines at gas metering stations.

STATION WHERE NATURAL GAS IS COMPRESSED



Heavy machinery is needed to increase pressure of the gas so that it might be transported long distances to consumers.

BOILER HOUSE OF COMPRESSOR STATION



sorption bulb and connecting tube, thereto, and enough surplus to allow for 10 c.c. in the reservoir. If too much solution is put into the pipette, the reservoir will overflow when the gas sample is passed into the absorption pipette.

Determination of Hydrogen Sulphide and Organic Sulphur Compounds in Natural Gas

Hydrogen sulphide has been found to exist in various supplies of natural gas. Usually, it is necessary to remove it before the gas can be sold to domestic consumers. Hydrogen sulphide has an objectionable odor, and in addition to this, when burned produces sulphurous and sulphuric acids with the water vapor formed by the combustion of the natural gas hydrocarbons. For these reasons, a qualitative test should be run on all natural gas from new sources to ascertain if hydrogen sulphide is present. If this test is positive, a quantitative test is necessary to ascertain its amount. The quantity is usually expressed in grains per 100 cubic feet of the natural gas tested.—See "Standards for Gas Service," Circular No. 32, Bureau of Standards.

The following are practically the standard methods of tests for hydrogen sulphide:—(a) Qualitative Test.

To determine the presence or absence of hydrogen sulphide in natural gas, it is only necessary to bubble a slow stream of the gas through a 5 per cent aqueous solution of lead acetate. The solution may conveniently be contained within a test tube or a graduated cylinder, and the gas to be tested can be delivered from a small valve on the supply line with the solution by means of a short length of rubber tubing. If hydrogen sulphide is present in the natural gas tested, a black precipitate of lead sulphide will be formed. The lead acetate solution will remain colorless, if hydrogen sulphide is absent.

An adaptation of this same test, consists of moistening white filter paper with the solution of lead acetate and allowing the stream of gas to impinge upon the paper. Hydrogen sulphide in the natural gas will color the filter paper dark, or even black. This lead acetate test is purely a qualitative one, and gives no indication of the amount of hydrogen sulphide carried in the natural gas.

(b) Quantitative Test

By the use of a Tutwiler burette, it is possible to determine quite rapidly and accurately the amount of hydrogen sulphide in a natural gas. For details of apparatus and methods of procedure in analyzing natural gas quantitatively for hydrogen sulphide, reference is made to Gas Chemists Hand Book, Second Edition, 1922, pages 332 to 335, inclusive.

In addition to a content of hydrogen sulphide, some samples of natural gas contain vapors of organic sulphur compounds. Again, there are samples of natural gas which do not have a content of hydrogen sulphide, but do contain vapors of organic sulphur compounds. The presence of organic sulphur compounds in natural gas may be proven by subjecting the gas to the test for "total sulphur" in accordance with apparatus and methods of procedure as described in Gas Chemists Hand Book, Second Edition, 1922, pages 339 to 342, inclusive, and in Circular No. 48, Bureau of Standards, pages 129 to 146. Natural gas gasoline which is recovered from natural gas containing hydrogen sulphide and organic sulphur compounds reacts "positive" to the doctor and corrosion test, methods 520.3 and 530.1 Technical Paper 323 A, Bureau of Mines.

Specific Heats of Natural Gas

One of the most constant of the physical properties of natural gas, or its components is known scientifically as specific heat. This property may be of considerable importance in subsequent studies on gas measurement problems. It is therefore on account of this possible utility of knowledge regarding specific heats of gases that this theme is presented.

The specific heat of gas is of two kinds: (1) specific heat at constant volume; and (2) specific heat at constant pressure.

When heat is communicated to gas, the volume of gas being constant, this heat may be utilized: (a) In increasing the temperature of the gas; and (b) in increasing the relative motion of the atoms making up the molecules of the gas.

When the gas is heated at constant pressure, additional energy to that specified above is required to perform external work or the gas expands. The specific heat of a gas at constant pressure is always greater than the specific heat of the same gas at constant volume. The relationship of one specific heat to the other is known as the ratio of specific heats. $\left(\frac{Cp}{Cv} = V\right)$ This ratio is highest with gas of the simplest composition and has a maximum value of 1.66 and the ratio is lowest with gases of the most conflex composition and has a minimum value approaching one.

The specific heat of natural gas at constant pressure (Cp) may be defined as the number of British Thermal units which are required to raise 1 pound of gas from 60 degrees Fahrenheit to 61 degrees Fahrenheit a constant pressure. The specific heat of natural gas at constant volume (Cv) may be defined as the number of British thermal units required to raise one pound of gas from 60 degrees Fahrenheit to 61 degrees Fahrenheit at constant volume.

The determination of the specific heats of gases, or their ratio, is a matter which requires first class equipment and technical skill.

The standard reference books contain data on the specific heats of some of the components of natural gas. The specific heat of the mixture is additive of the partial specific heats of the component gases. If the percentage-volume-composition of any sample of natural gas is known, the specific heat at constant pressure, or at constant volume, of this sample of natural gas may be calculated by multiplying the known specific heats of the components by the percentage compositions and by adding the products thus obtained.

If the reader is interested in a more complete discussion of the subject of specific heats of gases, reference is made to Edser's test-book—"Heat" and Luke's test-book "Engineering Thermodynamics."

Compressibility of Natural Gas

The volume of any gas is sensitive to changes of pressure. According to Boyle's law, the volume of gas, kept at one uniform temperature, varies inversely as the pressure. This law was formulated as a result of a study of Boyle covering charges in volumes over a pressure range varying from 3 centimeters to 300 centimeters of mercury. It has been found by experiment, that this law applies only to fixed gases in their volume-pressure relations of a very narrow range. The product of pressure and volume (Pv) is constant only within this range. (1) "With small pressures, outside of this range, the product, Pv, decreases with increasing pressure showing that the contraction with increasing pressure is less than is described by Boyle's law; (2) with large pressures, outside of this range, the product, Pv, increases with increasing pressure showing that the contraction with increasing pressure is greater than is described by Boyle's law; and (3) All gases, in consequence, show a minimum value for the product Pv. The pressure corresponding with the minimum depends on the nature of the gas and on the temperature. The minimum is less prominent with the more permanent, or fixed, gases than with the more condensible gases, or vapors."

Natural gas is not a fixed, or permanent, gas but is composed of hydrocarbon gases, which, when subjected to pressure show deviations from the volume-pressure relations which one would calculate from Boyle's law. Such deviations, as have been noted by experimenters in their studies of the deportment of natural gas, or any of its components from the view point of Boyle's law, are known as compressibility factors. The magnitude of these factors, in the case of natural gas, depends not only upon the pressure but also the nature of the components of the gas. Generally speaking; commercial natural gas does not show a deviation of any consequence at the pressures employed in large distributing systems. However, a large proportion of commercial natural gas, which is transported under high pressure, is of such composition that the magnitude of the compressibility factors is such that the industry may find it well to consider its significance. Technical Paper No. 158, of the Bureau of Mines, by G. A. Burrell and I. W. Robertson contains results of a study of the compressibility of natural gas from 31 cities in the United States.

The following interesting figure is taken from this Technical Paper:

A set of correction factors for deviations of gas from Boyle's law has been prepared by P. M. Biddison and may be found in "Natural Gas," 1923, June, page 30. The use of these factors depends upon a knowledge of the chemical composition of the natural gas in question.

A very practical metnod of determining the deviation, or compressibility factors, for natural gas is outlined in "Natural Gas," 1921, August issue. This method has been carefully worked out by the engineering department of the Standard Oil Co. of California.

Particular attention is directed to the study conducted by G. A. Burrell and G. W. Jones, United States Bureau of Mines, Reports of Investigations, Serial No. 2,276, entitled "Pressure-Volume Deviation of Methane, Ethane, Propane, and Carbon Dioxide, at Elevated Pressures."

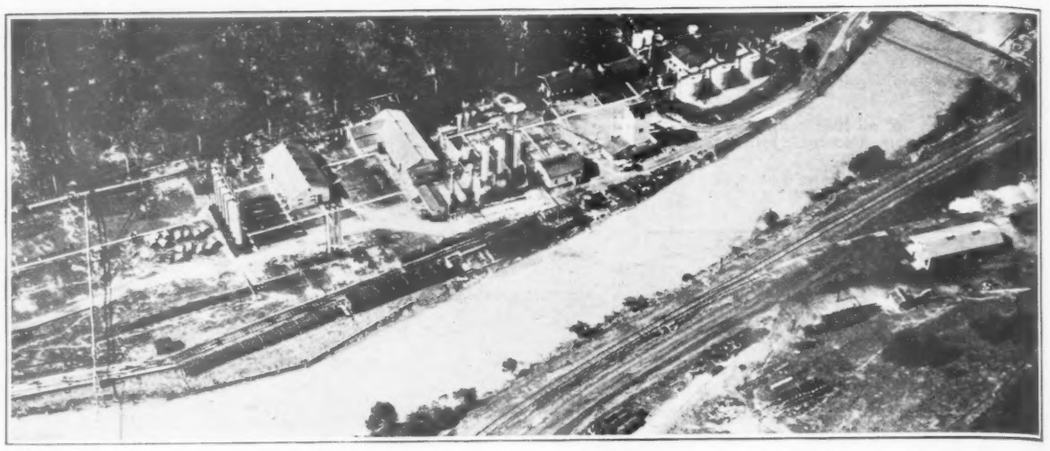
Specific Gravity of Gas

The measurement of large volumes of natural gas, under high pressure, by means of orifice meters, is a practice which has as one of its fundamentals, a knowledge of the specific gravity of gas.

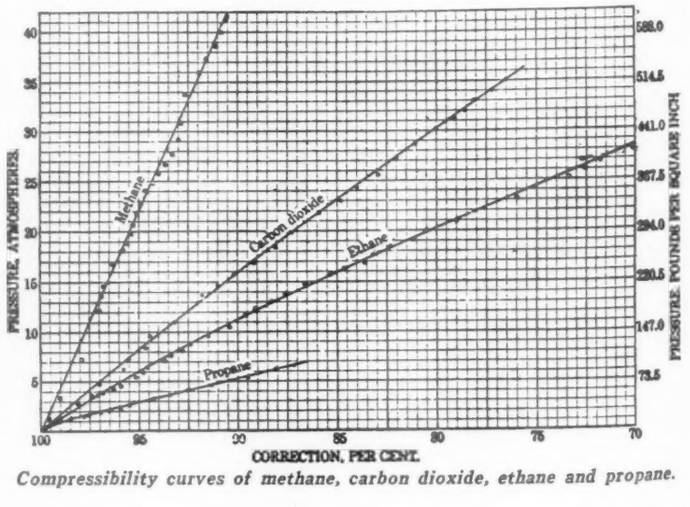
The term, specific gravity, means the ratio of a weight of a given volume of gas to a weight of an equal volume of dry air, free from carbon dioxide, measured at the same temperature and pressure. Unless it is otherwise expressly agreed, it is understood that the specific gravity of air is 1.0000 at a temperature of 60 degrees Fahrenheit and under a pressure equivalent to that of 30 inches of mercury at 32 degrees Fahrenheit.

Three methods of determining the specific gravity of gas are more or less generally used in the national gas industry: (a) the effusion method; (b) the specific gravity balance, and (c) the

NATURAL GASOLINE PLANT IN WEST VIRGINIA



The airplane looks down on the plant which helps materially in providing fuel for it and for the entire motor industry.



Compressibility curves of methane, carbon dioxide, ethane and propane.

method based upon calculations from results of accurate gas analysis.

Effusion Method

The construction of the effusion apparatus is well known to men in the natural gas industry.

The simplest method of determining the specific gravity of natural gas, for control and ordinary laboratory purposes, is that made possible by the use of the improved Schilling apparatus. The readiness and speed with which the determination can be carried out are factors which have very largely contributed to the widespread use of this method.

According to this method, use is made of Graham's law of diffusion: "The relative speeds of diffusion of gases are inversely proportional to the square roots of their relative densities, or specific gravities." By speed of diffusion is meant the time in seconds which is required for a fixed quantity of gas to pass through a small opening, or orifice. Specific gravities are therefore proportional to the squares, of the times of effusion of gas and air. By determining the times of effusion of equal volumes of natural gas and air, under the same temperature and pressure, through the same orifice, the specific gravity of natural gas may be calculated as follows:

$$\text{Specifiv gravity} = \frac{t^2 \text{ (gas)}}{t^2 \text{ (air)}}$$

t—Time in seconds as measured by a stop watch.

Schilling Apparatus

The Schilling apparatus consists of a glass jar, approximately 3.5 inches in diameter by 12 inches tall, with an enlarged base. A brass plate is cemented on the jar at the top. The brass plate carries an armored glass tube which screws into position on the plate above the jar. At its upper end, this tube carries a three-way stopcock into which fits a small, well protected, glass tip. A small platinum disc, with orifice made in the center thereof, is sealed into the glass tip. The inner glass tube is graduated so that the volumes of natural gas and air may be closely observed.

The procedure in conducting a specific gravity determination by means of the Schilling apparatus is fully described in the following publications: (a) Gas Chemists Handbook, Page 208; (b) White's Gas and Fuel Analysis, Page 181, and (c) in circular of the American Meter Co., entitled "Specific Gravity Apparatus."

The following statement relative to the effusion method has been taken from Circular No. 48, Bureau of Standards, entitled "Standard Methods of Gas Testing," Pages 178 and 179:

"The effusion process, as it occurs in the various forms of apparatus now in use, is not so simple as indicated by the square root relation. Quite a number of factors other than the density of the gases affect the relative rates of effusion. Of these may be mentioned thickness of orifice plate and size and shape of orifice, the pressure under which the gas effuses, the ratio of the specific heats, the viscosity of the gas, etc. The quantitative effect of several of these factors has not been determined as yet.

"The character of the orifice used is a factor of prime importance. The plate in which it is made (usually platinum) should be as thin as practicable; platinum-iridium as thin as 0.02mm can be used for this purpose. The orifice should be smooth and round without any projecting burr. The orifice should be as large as possible, giving consideration to the time of outflow necessary for the required accuracy of timing.

"When water is used as the confining liquid in the effusion apparatus, considerable care must be exercised to eliminate, so far as possible, the error due to condensation of moisture in the orifice. Condensation is indicated by a decreasing rate of effusion as shown by an increase in successive times. This may be a serious source of error and should be guarded against by passing dry air or gas through the orifice before use as often as may be necessary. The orifice should never be dried by heating over a flame. The trouble due to condensation of moisture in the orifice is eliminated in those forms of apparatus which use mercury as a confining liquid.

Importance of Pressure

"It is important that the apparatus should always be operated with the same pressures at start and finish of the timing. The excess of pressure above atmospheric at the end of the time interval taken should not be less than 2 inches water pressure; preferably it should be somewhat greater. The initial pressure should not be too high, generally not over 20 inches of water pressure should be allowed.

"In filling the apparatus with gas, it is essential that the method employed be such as to introduce a sample uncontaminated by air. It is probably better to fill the apparatus with gas which is practically at the temperature of the apparatus and which has been saturated with water vapor previous to its introduction into the apparatus, unless the gas is being measured dry or partially saturated in an apparatus using mercury. When the orifice tube is filled with air at the beginning of a run, the timing should not be begun until sufficient gas has passed through to sweep out all of this air.

For a specific gravity determination, several consecutive runs should be made on both gas and air. With a time interval less than 2 minutes, it is probably necessary to secure three or four intervals which agree within one-half of 1 per cent before the average can be considered as satisfactory. Any series of results in which the effusion time is constantly changing in one direction should be discarded.

"In order to determine the degree of accuracy secured with any instrument under certain operating conditions, it is necessary to compare the results so obtained with the density of the same gas determined by an accurate weighing method. Apparatus calibrated in this manner may be used with some degree of satisfaction provided the physical properties of the gases tested do not differ greatly from those of the gas with which the calibration was made."

The Schilling apparatus is essentially a field instrument, when it is used by a careful operator and is properly maintained and inspected. One of the large eastern natural gas producing companies has used calibrated instruments of this type for its specific gravity determinations. All of the instruments thus used were carefully calibrated in the laboratory against the Edwards specific gravity balance, using a gas of approximately the same specific gravity for standardization, as the gas to be tested. Only those orifices were used, which carried very small correction factors. The instruments in field use were regularly inspected and checked in the laboratory for their accuracy. The following results, taken from one series of control tests, may be of interest in this connection:

Instrument Number	Tip Number	Specific Gravity by Instrument	True Specific Gravity	Correction
N	A	0.5643	0.6219	+0.0576
O	28	0.6122	0.6219	+0.0097
11	B	0.6144	0.6219	+0.0075
49	X	0.6031	0.6219	+0.0188
20	26	0.6018	0.6219	+0.0201
44	8	0.6175	0.6219	+0.0044
43	23	0.5866	0.6219	+0.0353
30	1	0.6071	0.6219	+0.0148
37	C	0.5924	0.6219	+0.0295
4	D	0.5732	0.6219	+0.0487
K	E	0.5617	0.6219	+0.0602

Of the 11 instruments tested only three were regarded as suited for field work. The instruments referred to are those numbered O, 11 and 44, of which the correction factors were +0.0097, +0.0075 and +0.0044.

It has been found as a result of careful checks that effusion instruments used under such restrictions give most dependable results. The results thus obtained are reproducible on the Edwards balance and by calculation from results of chemical analysis.

Specific Gravity Balance Method

This method is regarded as precise and accurate in the determination of specific gravity of natural gas for scientific and technical purposes. The apparatus employed is of such nature that the highest possible accuracy can be attained only when its several parts are kept in first-class condition and when operated under the most favorable circumstances. The treatment accorded the balance and the skill employed in its operation will determine largely the accuracy obtained in its use. The Edwards balance is essentially an appliance for use under other conditions than those which usually prevail in the field. Highly satisfactory results are obtainable in the use of the Edwards balance for the determination of specific gravities of natural gas, samples of which have been carefully taken in proper containers in the field and delivered to the laboratory for test.

It is of importance, however, to note, at this point, that specific gravities which have been calculated from results of accurate gas analysis are uniformly in very close agreement with specific gravities determined by means of the Edwards balance. The authors feel that both methods of procedure are dependable and accurate for all gas measurement purposes.

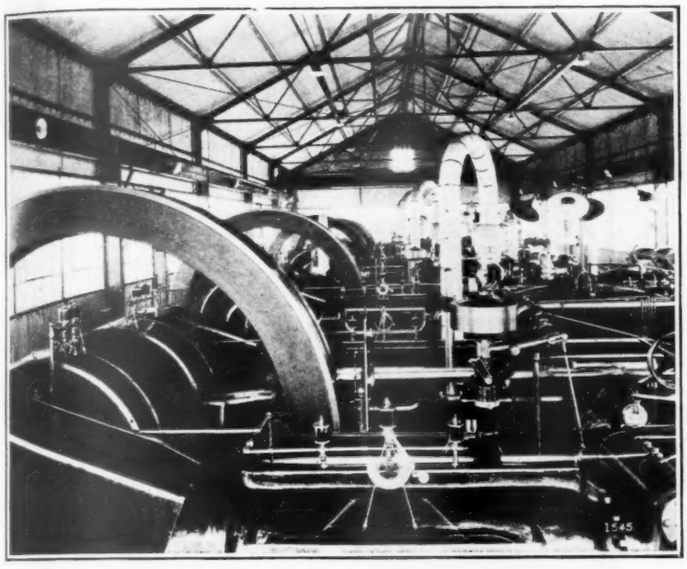
Circular No. 89 of the Bureau of Standards entitled "A Specific Gravity Balance for Gases" by J. D. Edwards contains a complete statement of: (a) principle of method; (b) description of apparatus; (c) operating directions; (d) source of error in use of the balance; and (e) accuracy of method.

Methods Based Upon Calculations From Results of Accurate Gas Analysis

Elsewhere in this issue, two methods of natural gas analysis have been described: (a) Proximate methods of gas analysis; and (b) analysis by fractionation at low temperature. Results of analysis conducted according to either of these two methods can be used most safely for the calculations of specific gravity of gas. It is generally accepted that the specific gravity of a mixture of gas under standard conditions of temperature and pressure is the sum of the partial specific gravities of its components.

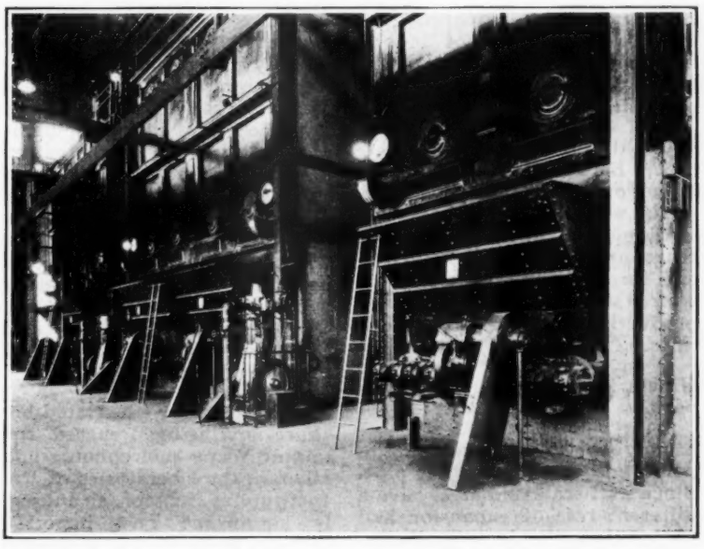
The matter of the determination of specific gravity of natural gas is of first importance in the natural gas industry, and it is to be hoped that subsequent investigation will result in development of apparatus and method which will give the industry a dependable source of information of specific gravity of natural gas under pressures which simulate those obtaining in the pipe lines at gas metering stations.

STATION WHERE NATURAL GAS IS COMPRESSED



Heavy machinery is needed to increase pressure of the gas so that it might be transported long distances to consumers.

BOILER HOUSE OF COMPRESSOR STATION



Announcing — a practical solution of pipe line corrosion • • • • problems • • • •

Recent tests at W-K-M Shops on two joints of new 8" line pipe clearly reveal why painting has heretofore proven relatively ineffective in preventing pitting and corrosion, and point out a practical solution of corrosion problems. - - - - - - - - - -

Boiled down to its essence, our solution of pipe line corrosion and pitting problems involves simply this: PAINT THE PIPE.

Offhand, you may argue that you have been doing this.

But, have you?

Glance for a moment to the bottle illustrated to the right. Here is a collection of 2 pounds and 5 ounces of pure mill scale taken from a single joint of brand-new 8-inch line pipe just unloaded from the car. In volume, the collection measured approximately three-fourths of a quart of scale.

Before this scale was removed, it formed a complete envelope around the joint of pipe from which it was taken. This envelope, which is typical of the kind that encloses every joint of new pipe, absolutely prevents paint or other preservative coating from actually forming a bond with the naked steel of the pipe to be protected.

Here then, is an inescapable answer to the problem of how to halt corrosion and pitting on buried lines costing thousands, even millions, of dollars.

Clean the mill scale from your pipe. Bare the naked steel just ahead of your dope gangs and then, when your preservative coating goes on, it will adhere tenaciously to the steel itself, and form an impervious barrier which should add years to the productive life-span of your lines.

Unless you do this, what happens?

Simply this: you continue to paint "mill scale," and not pipe. Since mill scale and steel have a different rate of expansion and contraction, the scale tends inevitably to peel off the pipe, taking the preservative coating with it. You have seen hundreds of joints of pipe removed from the ground which appeared to have been scoured of both mill scale and paint. This was the result of the mill scale peeling from the pipe, and taking the preservative coating with it.

In its Pipe Cleaning Machines, the W-K-M Company, Inc., offers an ideal means of removing all mill scale from either single joints of pipe before they are strung into the line, or of made-up pipe lines ready to be coated. In addition to cleaning all mill scale from the pipe on which they are used, these machines also leave behind them an exceptionally fine surface for promoting a tight bond between steel and preservative coating. As the machine passes over the pipe, its cutters leave thousands of minute ridges and grooves on the surface. These tiny ridges have curled edges which tend to grip and hold the paint in the same way that metal lath grips plaster or stucco. Preservative coatings applied to pipe cleaned the W-K-M way enjoy a thousand-to-one chance for long, useful, protective life.

In a handsomely illustrated brochure now being prepared, containing many microphotographs taken in the laboratories of Rice Institute, at Houston, an unusually significant and important story is being written for the attention of pipe line company executives interested in extending the life of their investments in natural gas or oil lines.

In this booklet is to be given the description of a test recently conducted at the W-K-M Shops in Houston, together with a full statement of the astonishing facts revealed by the test. This information will be supplemented by semi-technical comments by two thoroughly practical members of the Engineering Staff of the Rice Institute, Messrs. Arthur J. Hartsook, Chemical Engineer, and J. H. Pounds, Mechanical Engineer.

The mill scale contained in the bottle illustrated above, weighing 2 pounds and 5 ounces net, was removed, in a remarkable test, from a single joint of brand-new 8-inch line pipe with a Travelling Type W-K-M Pipe Cleaning Machine. The eight-ounce glass beside the bottle gives you an idea of the volume of the mill scale removed. Write for a copy of our new booklet giving the astonishing results of this test, and showing microphotographic pictures of the pipe surface before and after cleaning.

Copies of the brochure will gladly be mailed on request to anyone interested in the subject of controlling corrosion and pitting on pipe lines. Use the coupon below, or a postcard, whichever is convenient.

Use this coupon to obtain complete Data

W-K-M COMPANY, *Inc.*
HOUSTON, TEXAS.

GENTLEMEN:—We are interested in ways and means of preventing pipe line corrosion and pitting and without obligation you may send us a copy of your booklet on this subject.

Name .....

Street .....

City and State .....

Reclaiming 29 miles of 8" screw line in Texas, after eight years in the ground. Two men, an operator and an attendant, are running a W-K-M Pipe Cleaning Machine over the line as it is raised from the ditch by a W-K-M Pipe Handling Boom, mounted on a Fordson Tractor. Note the cloud of flying dust, dirt, rust, scale and corrosion emanating from the business end of the machine. Perfectly cleaned pipe at a cost ranging between 20c and 30c a joint. Speed ranging between one-half and three-quarters of a mile a day.

A day "on the line" in Texas cleaning 8″ pipe

Next to pure reading matter, with some pictures thrown in, to show you how modern machinery has revolutionized pipe cleaning and reconditioning work in the field as well as in the yard and shop.

Something important is happening in the pipe line business.

The picturesque armies of men who have always been associated with the work, are gradually fading from the scene.

In their stead, phase after phase of pipe lining is being entrusted to new and often remarkable machines—especially developed for the purpose.

Witness the illustration above.

Two men, you will note, are cleaning a made-up, 8-inch screw line—and doing a perfect job—at the rate of 150 to 170 joints a day. By way of contrast, recall mentally the last job of hand cleaning you saw. Probably it was a gang of 75 or 80 men pecking soberly at the pipe with sharpshooters, rasps, files and wire-brushes, wasn't it? Quite a difference!

To perform the work of 75 men, the two boys shown are using a W-M-K Pipe Cleaning Machine —traveling type. Propelled by its own power, it proceeds over the line at a speed governed by the condition of the pipe—usually from one-half to three-quarters of a mile per day. Its work is perfect — impartially perfect. The bottom of the pipe comes in for exactly as vigorous a cleaning as the top and sides. The machine knows no favorites, and, where it has passed, the line is ready for the protective coating. Not only the visible, but the invisible, difficult to reach portions as well. There will be a perfect bond between pipe and protective coating.

Pipe line men of the old school will find it difficult to believe that four men, with a W-K-M Pipe Handling Boom, can raise and skid any size pipe line at the rate of two or three miles a day after it has been stripped. The cost is far below that of the best previous way of doing this work.

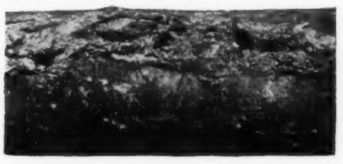
But, pass on.

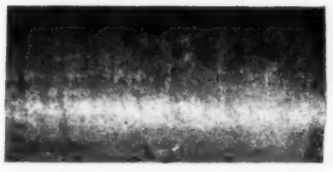
Here's another innovation almost as great as mechanical pipe cleaning. The picture at the bottom of the page, left, shows a Fordson Tractor, equipped with a W-K-M Side Winch and a W-K-M Pipe Handling Boom. The outfit is taking the place and doing the work of thirty or forty men. Here, it is raising the line from the ditch, after the pipe has been partially stripped. Real progress, isn't it, when four men can be detailed to raise and skid an 8-inch, made-up screw line? Four, instead of forty?

Here the W-K-M Boom, having lifted a mile or so of pipe from the ground and put it on skids, has returned to help speed up the pipe cleaning work. The boom lifts the pipe ahead of the machine, and enables it to pass over the skids.

Actually, the four can raise and skid twice as much pipe with the machine as a gang of forty can raise with the best previous hand tools. The real work, of course, is done by the machine. The men, as a result, have only to operate it. A really notable difference—both in results and in cost!

The Boom's day of labor is not finished, however. Having raised half a mile or more of line in advance of the cleaning operations, the outfit has returned to work with the Pipe Cleaning Machine as shown in the small center illustration. It raises the pipe from the skids, so the Cleaning Machine may pass without stopping. System, here, and a minimum of manual labor—more than ever, today, the most costly commodity on the market.





"Before" and "After" taking a dose of W-K-M Pipe Cleaning Machine work. The upper picture shows a section of the pipe before it was cleaned. The lower picture shows the same section after the machine passed over it.

When finished, what have they accomplished?

The "before and after taking" pictures are shown in the upper right hand corner of this page. They speak for themselves, quite eloquently.

Here, then, is an 8-inch line being reclaimed by a handful of men in lieu of the former "army." Significant, this, and worthy of your thorough investigation, in which we shall be glad to assist you in every way. Several interesting illustrated descriptive bulletins have been prepared on special W-K-M Pipe Line Equipment, and we shall be glad to send you copies. The coupon below, or a brief note on your letterhead, will bring them, together with any other information you may wish. Have your secretary send today.

W-K-M COMPANY, Inc.
HOUSTON — TEXAS
Interesting Literature Sent Free

W-K-M COMPANY, *Inc.*
Houston, Texas.

Gentlemen:—Without obligation we will be glad to know more about the machines you make for pipe line construction work.

Name .....
Street .....
City .....
State .....

Gas Compressing Stations Big Factor

Available Machinery for Increasing Pressure Raised to High State of Efficiency. First Compressor in 1880

By S. C. Preston
Assistant Chief Engineer, Peoples and Affiliated Natural Gas Companies

Compressing stations, as applied to the natural gas business, are used to gather gas from groups of gas wells by lowering the line pressure into which they feed and to deliver this gas to the consumer through pipe lines by increasing or raising its pressure. The art of compressing natural gas is about as old as the industry itself, for those who first engaged in the business soon found that the natural pressure of the gas in the producing sands, or rock pressure, gradually became less as the gas was taken away, and that some means of restoring the pressure must be provided to force the gas through the lines to the market. After some experiments on a small scale, the first gas compressing station was constructed in 1880 by the Bradford Gas Co., at Rixford, Pa., which is about 13 miles from Bradford. The machinery consisted of a Clayton duplex gas compressor direct connected to a steam engine. The gas cylinders were 24-inch diameter by 26-inch stroke and had a daily capacity of about 5,000,000 cubic feet. The pressure necessary to market the gas was about 50 to 60 lbs., and by reducing the line pressure on the wells plenty of gas was available for the demands.

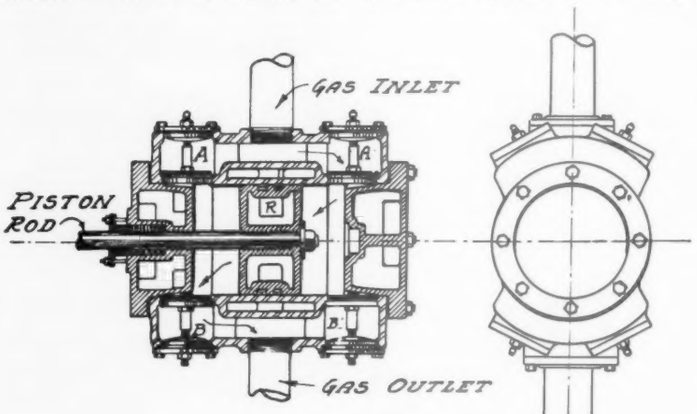


FIG. 1
COMPRESSOR CYLINDER

In the year 1890, a station of about the same capacity and type was built at Murrysville, Pa., to increase deliveries to the city of Pittsburgh. The machinery was furnished by the Hall Steam Pump Co. and the plant soon after was enlarged when the gas company found it could supply a variable demand for gas by using gas compressors.

At the present time the available machinery for compressing gas is developed to a high degree of efficiency and the gas engine particularly has been perfected to meet the demand by natural gas companies for its use in gas compression.

Typical Compressor Cylinder

In order to get some idea of the construction of a compressor cylinder and its operation, a longitudinal cross section of a typical cylinder is shown in Figure 1.

This apparatus consists of a cylinder in which moves a reciprocating piston (R) so arranged to move as close as possible to each end with reasonable allowance to avoid striking the cylinder heads. This space plus, the passageways to the inlet and discharge valves A.A. and B.B., is known as the clearance. That volume of space displaced by the stroke of the piston is called the displacement. The valves are constructed to permit the flow of gas in one direction only. Those valves marked A. A. are known as inlet valves and permit the gas to flow into the cylinder only, while those marked B. B., called the discharge valves, permit the flow of gas out of the cylinder only.

Let us assume that the piston is at the left-hand end of the cylinder and moves to the right. A vacuum would be created on the left-hand side of the piston were it not for inlet valve A, which opens as soon as the pressure on its lower side becomes less than the inlet gas pressure on the upper side of the valve. Gas then flows into the cylinder until the piston stops at the end of the stroke and the cylinder is filled with gas at the pressure of the inlet gas. We will now assume that the piston moves in the opposite direction and the same operation takes place on the right-hand side as that just described on the left, but on the left-hand side the gas is compressed and the pressure raised to a point slightly higher than the discharge line pressure. The discharge valve then opens and the gas is forced through the valve and out into the discharge line. When the piston stops moving there is gas in the clearance space at discharge line pressure which cannot be displaced by the piston and therefore remains there and when the piston travel is reversed, expands to a pressure slightly below the suction line when the suction valve opens due to this difference of pressure and this cycle of operation is made for every revolution of the machine.

When Gas Is Compressed

When gas is compressed the volume is reduced and the pressure is raised. The ratio of the reduction of volume to the original is known as the number of compressions and is found by dividing the absolute discharge pressure by the absolute suction pressure. By single stage compression we mean that accomplished in a single cylinder. When the number of compressions exceeds 5 or 6 then two cylinders should be used with a cooler between, the smaller or high pressure cylinder receiving the gas from the larger low pressure cylinder. This is called double staging the gas and has many advantages over doing the same operation in a single cylinder. The principal advantages are less power is required, more efficient compression is obtained, lower temperature maintained and considerable weight of machinery saved by using a small heavy cylinder for high pressure and a large light cylinder for low pressure. The most economical operation is obtained when operating at about 2½ to 3 compressions.

In designing a compressor cylinder, the velocity of the gas through the valves or passageways should not exceed 6,000 feet per minute. The smaller the valve area or opening the greater will be the velocity of the gas and the greater the drop in pressure of the gas in passing through. This is true of both suction and discharge valves and simply means an unnecessary loss in power and gas pumped as the differential pressure on the sides of the piston is increased and the gas is compressed through a greater range of pressure than is needed. In other words, the friction of the gas through the valves should not be enough to add appreciable work to the compressor. Since the speed of the piston is maximum in the center of the cylinder, the velocity of the gas is greatest through the valves at this time and the fact that this velocity decreases to zero at the end of the stroke not only gives the cylinder a chance to get well filled with gas on its suction stroke but reduces the velocity of the compressed gas on the discharge stroke of the piston.

High Speed Compressors

On high speed compressors it is sometimes difficult to get enough room in the compressor heads to use valves of sufficient size and not at the same time get too much clearance space. This is accomplished by making the ends of the piston and cylinder heads of conical shape. It is very desirable to keep the clearance space as small as possible. The reason is, that as the clearance is increased the amount of gas pumped diminishes, due to the fact that a large amount of gas is available to expand on the suction stroke of the compressor and prevent that amount of gas from the suction line from entering the cylinder. The above condition is further aggravated as the number of compressions is increased, because the clearance gas, when expanded through a range of five compressions, fills more cylinder space than when expanded through a lesser number. When the amount of gas pumped through a given range of compressions is decreased by added clearance the power required is accordingly reduced.

Many designers have taken advantage of this fact and provided clearance pockets in the cylinder heads which may be operated by an ordinary valve while the compressor is in motion. This is shown on Figure 2. The advantage of these pockets is that by changing the clearance the maximum amount of gas may be pumped by keeping a full load on the power unit and preventing an overload. Since the power required depends on the volume of gas pumped and the range of pressure through which the gas is compressed, we know that as our pressures change the power required changes and likewise the volume of gas pumped. Clearance pockets, therefore, offset pressure changes and keep the load uniform which insures the most delivery of gas. Since overloading can be prevented by clearance pockets it is well to install a compressor cylinder of larger diameter than would otherwise be used. This gives the advantage of being able to pump large quantities of gas when the discharge pressure is low by closing the clearance pockets.

Maximum Load

The maximum load on a compressor for a given discharge pressure takes place at about 2½ to 3 compressions. That is, if we have 100 pounds absolute discharge pressure divided by the absolute suction pressure of 40 pounds, giving 2.5 compressions, it may be said that the load is maximum. If the discharge pressure is kept the same and the inlet or suction pressure increased above 40 pounds, or dropped below, the load would decrease. Therefore, if a cylinder was designed to load the power unit at 3 compressions and this was reduced to 2.5 compressions, by increasing the suction pressure, the load would be very much increased and it would be necessary to increase the clearance to prevent overloading.

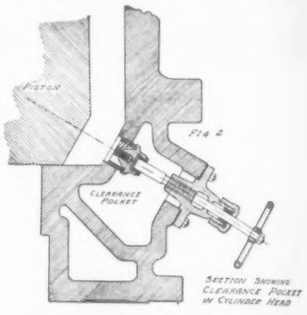


FIG. 2
SECTION SHOWING CLEARANCE POCKET IN CYLINDER HEAD

In recent years compressor builders have all adopted what is known as the plate type of valve, as shown on Figures 3 and 4, for general gas pumping service. These consist of a light circular hardened steel plate, backed up by light springs for closing the valve. Light rectangular steel strips are also used with the same results. The advantages over the old poppet valve are, they require less power to operate, have larger valve area, permit high speeds, due to low lift and light weight, wear longer and are easier to replace.

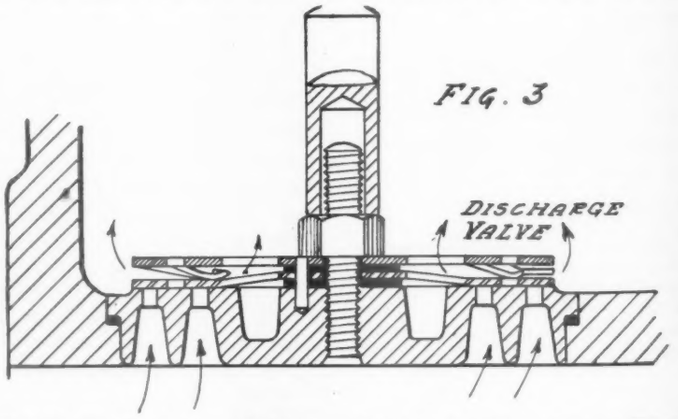


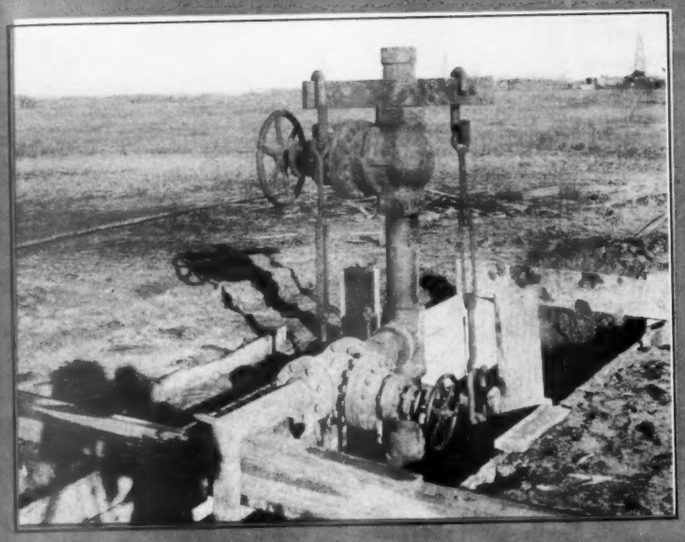
FIG. 3

Removable Liners

Owing to the decline of gas fields and changes in pressure requirements at different times during the year, compressors are usually purchased with removable liners. Some cylinders are de-

VALVES KEROTEST FITTINGS

SAFEGUARD THESE AND MANY OTHER SIMILAR GAS WELLS



On the Largest Gas Well in Northwestern Oklahoma

KEROTEST HIGH PRESSURE VALVES are guarding Geiger No. 3 well—a 45 million gasser belonging to the Blackwell Oil & Gas Company of Blackwell, Oklahoma. — Just another instance of the confidence operators place in the Kerotest line of Valves and Fittings for severe high pressure service.

The Dixie Oil Company

Have equipped both their Dillon Wells, No. 43 and No. 53 at Pine Island, La., with KEROTEST VALVES AND FITTINGS. The photograph to the right shows a close-up of Dillon No. 43.

To be sure your wells are properly protected—follow the example of the leading drillers throughout the country. They specify KEROTEST and play safe. Any of the Kerotest Distributors will be glad to serve you.

Kerotest Manufacturing Company

Pittsburgh, Penna.

Carried in stock and sold by

GRINNELL CO. OF THE PACIFIC
Los Angeles San Francisco

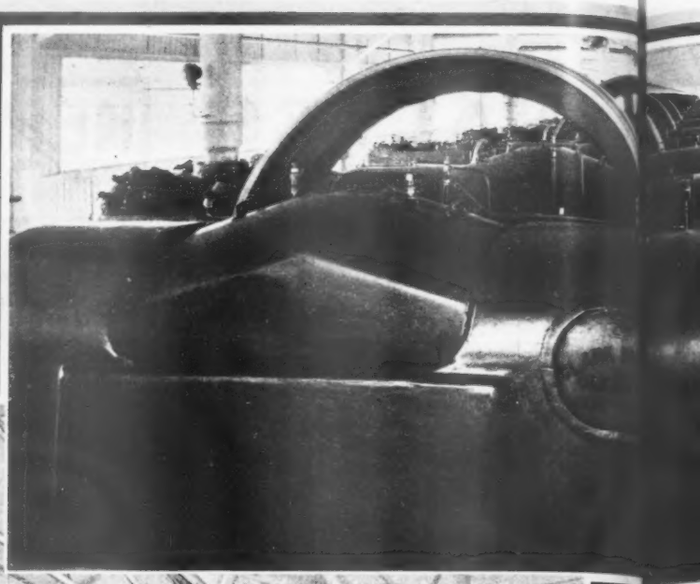
NORVELL-WILDER HARDWARE CO.
Houston Beaumont Shreveport Fort Worth

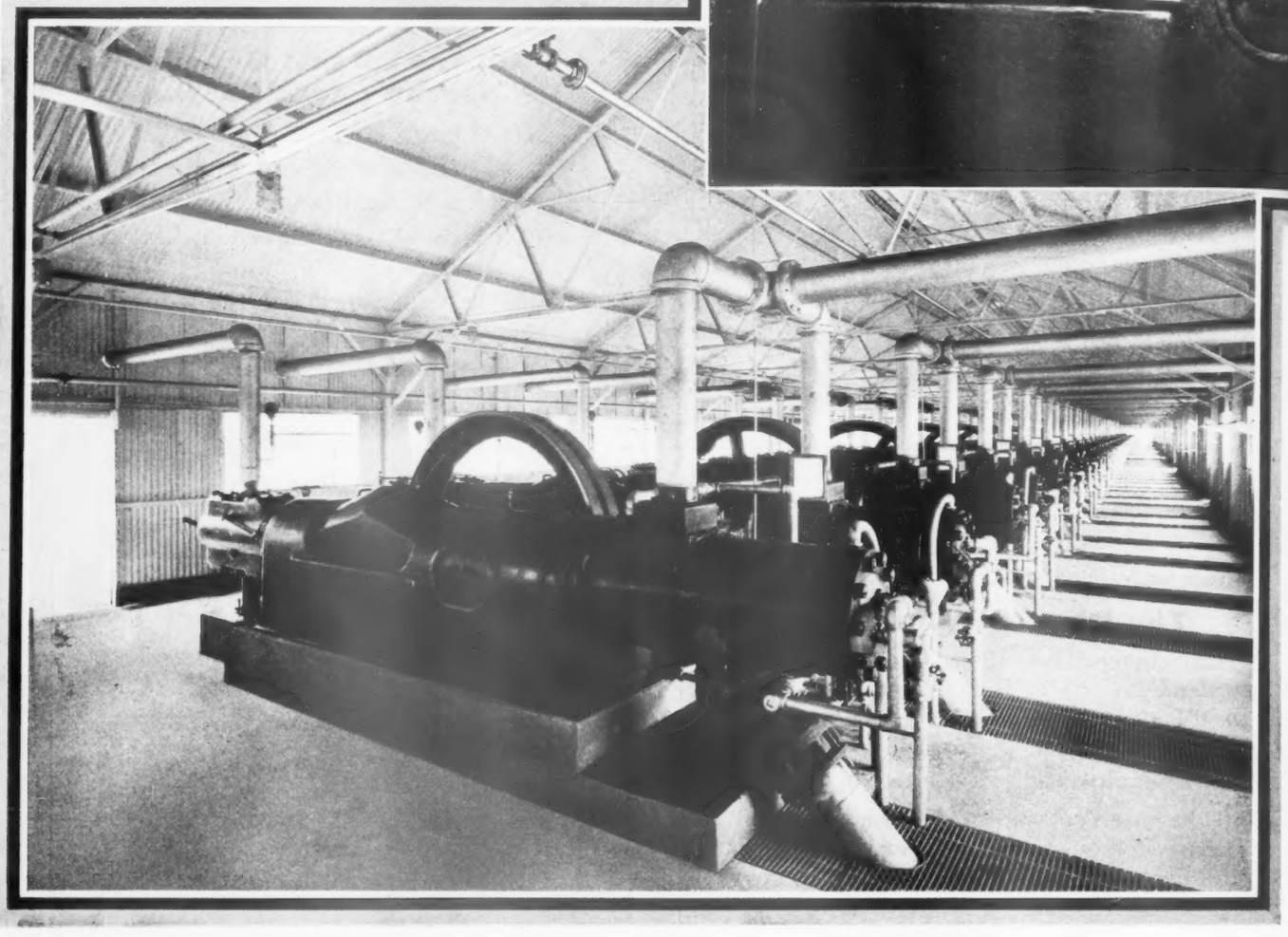
OIL WELL SUPPLY CO.
Oklahoma Kansas Colorado Wyoming

Export Distributors

OIL WELL SUPPLY CO.
Pittsburgh New York Tampico London

Clark Bros. Co.
OLEAN, N.Y.

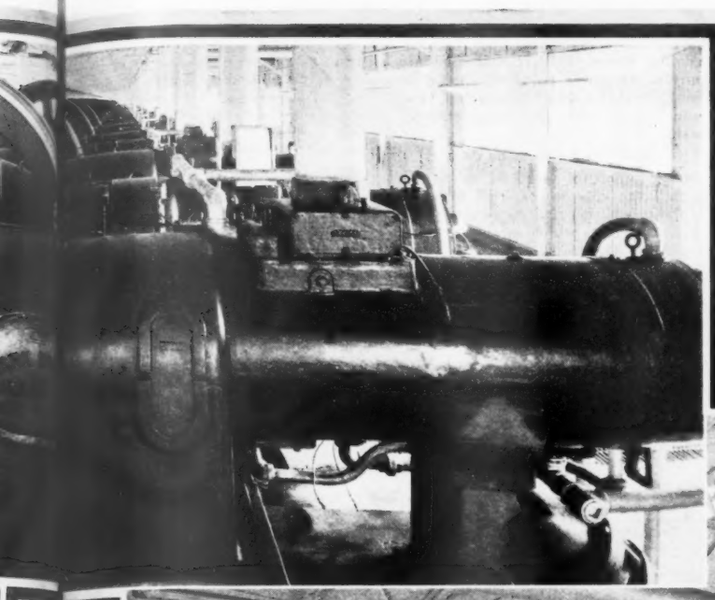




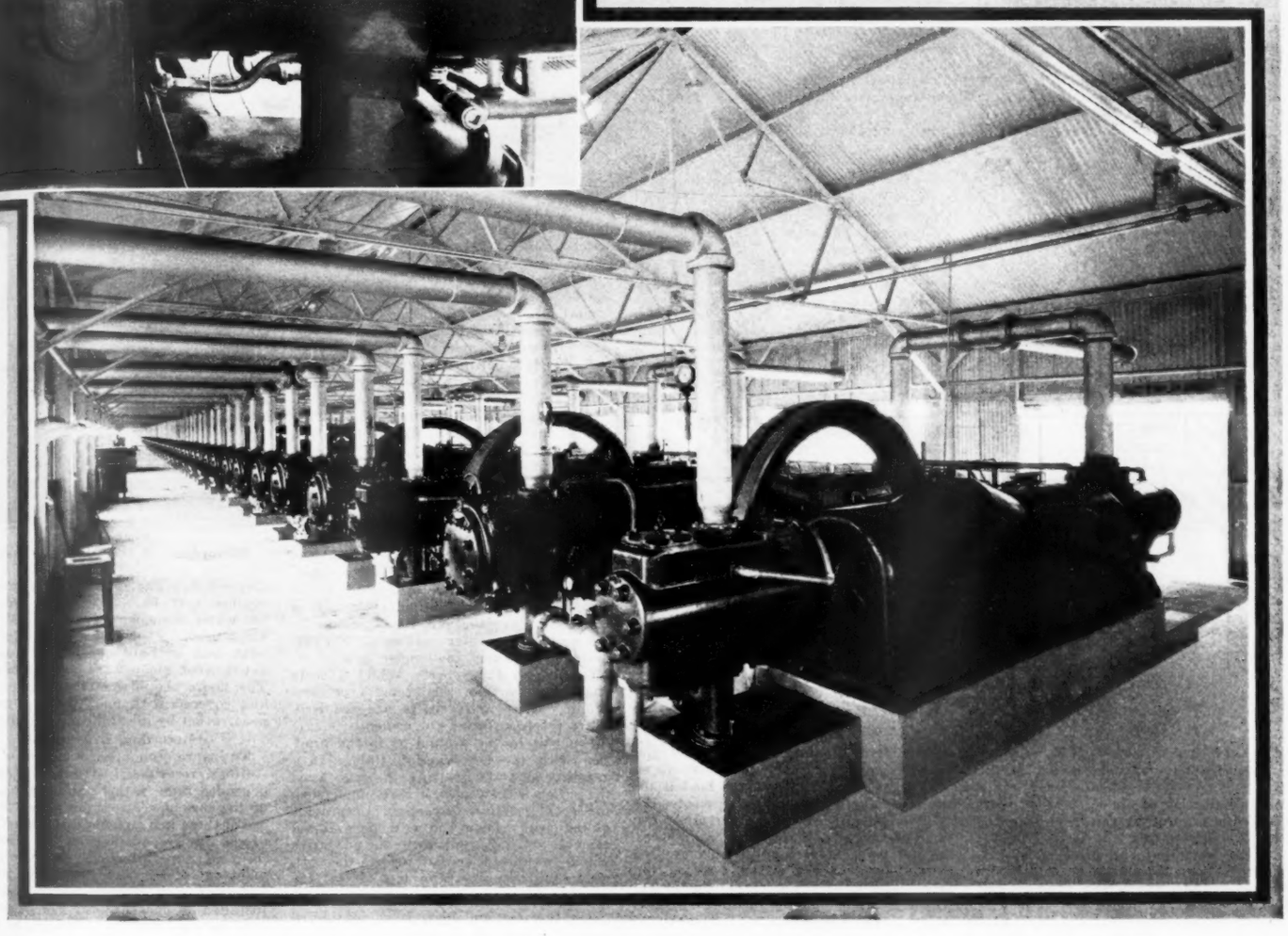
Phillips Petroleum Company

CLARK BROS. COMPANY
Olean, N. Y.
or
125 W. First Street, Tulsa, Okla.
Warehouses at Sweetwater and McCamey, Texas, and Artesia, N. M.

CLARK COM



Clark Bros. Co.
OLEAN, N. Y.



ys Borger Plant - Borger, Tex.

SMITH-BOOTH-USHER COMPANY
228 S. Central Ave., Los Angeles
50 Fremont St., San Francisco

MPRESSORS

signed so that the work of making this change can readily be done in the field in a half day's time. In changing the liner, which really means changing the diameter of the cylinder, the machine is adapted to any given pressure conditions so that the unit is loaded to its horsepower capacity.

In the compression of natural gas it is interesting to observe just what is accomplished. As gas is compressed the temperature rises and the heat equivalent of the work done depends upon the rise in temperature of the gas. It will be noted in Figure 1 that there are water jackets through the cylinder walls through which cooling water constantly flows. This water tends to reduce the gas temperature and after it passes through the cooler it is, we will assume, back to the same temperature as it entered the station. This means that all the energy used to compress the gas has been carried away in cooling water, radiation, etc. The gas has simply been made available for expansion in the pipe lines, and if the gas reaches its destination at the consumer having the same temperature as it came from the cooler at the compressing station, all the energy to transport the gas through the line has been absorbed from the ground around the pipe line in the form of heat.

Designing a Station

In designing a compressing station the information necessary to determine the size is the amount of gas to be handled and the range of pressure through which it is to be compressed. Care must be taken to provide additional capacity for heavy demands during the day and one or two spare units for emergencies. The amount of gas to be handled is sometimes difficult to estimate owing to the drilling of new wells and the uncertainty of the production of old wells when their pressure is lowered by the installation of a compressing station. It is very important, however, that the pressure on the wells to be pumped should be kept below that point where the minute raise of well pressure shows a decrease. Otherwise the well will not feed its capacity which is evidence that the station is poorly located or the suction line too small.

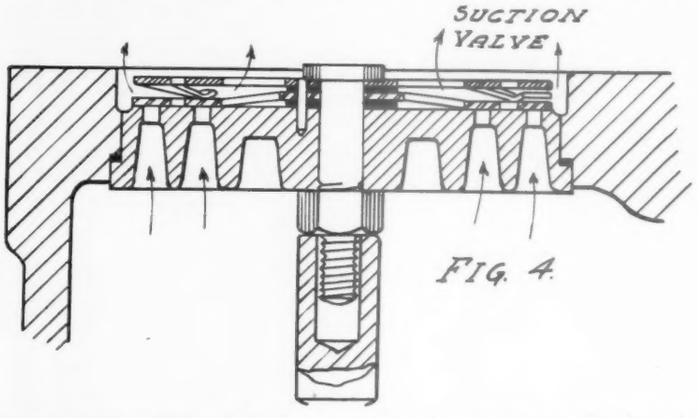


FIG. 4.

In selecting the location of a field station, a site is generally obtained along the line into which the gas is to be delivered, at a point where a good water supply is available. This location should be made with careful consideration of the suction lines which may be necessary to lay to connect the wells to the station. The question of floods, character of the soil for engine foundations, possibly of water supply from drilled wells, and future station enlargements should be considered at this time. If the location is for a booster station, on a long transmission line, the choice and number of stations should be made so that the sum of capital and operating charges, for both pipe line and compressing stations, is minimum.

Type of Power

The type of power to be used is generally determined by the location of the station. The various types in use today all have an application to a particular location and serve best when properly applied. The gas engine is used extensively for every sort of station. It is more efficient than the steam engine and the availability of gas for fuel always demands its consideration. In order to understand the fundamental difference between the steam and gas engine it is well to investigate the operation of their power cylinders.

The gas engine is provided with a speed governor which automatically controls the amount of explosive mixture of air and gas which is drawn into the power cylinder to drive the engine and maintain the speed at which the governor is set. When this mixture is compressed on the return stroke of the piston and ignited by an electric spark, a very high temperature and a pressure is created on one side of the piston. When the engine is fully loaded or overloaded slightly this pressure may reach 400 pounds per square inch and, while it decreases rather quickly as the piston moves forward, it is nevertheless necessary to design the engine parts, such as bearings, rods, shaft, cylinders, etc., of such size to withstand the high initial pressure or shock which the engine receives at this time. The high cylinder temperature must also be carefully considered or serious mechanical troubles will result. Therefore, since the initial cylinder pressures and temperatures become higher as the load increases, it is evident that the gas engine should not be overloaded as a general practice.

The steam engine also has a speed governor which automatically controls the amount of steam entering the power cylinder to drive the engine. Since the pressure of this steam is about the same as that of the boilers and generally less than 200 pounds per square inch, it is evident that the strains throughout the various parts are much less than those of the gas engine. When the load is increased more steam is admitted to the cylinder but always at approximately the same pressure, so that the forces at work are not made greater but simply applied over a longer period of time to get the increased power. Therefore, the steam engine is better adapted to take overloads than the gas engine.

Question of Fuel

The question of using a coal or gas-fired steam plant is principally a question of the value and availability of the two fuels at the station sight. A steam plant does best when operating on large quantities of gas over long periods, and can be forced to full capacity and overloads and still maintain its reliability and efficiency. This is largely on account of the great overloads a modern boiler plant will carry. Because of the wide range of speed of the steam engine and the variable torque, the regulation of pressures and volumes of gas is much easier accomplished than with the gas engine. On a widely fluctuating load the overhead and standby losses on a steam plant may be said to exceed that of the gas engine. For very small plants, of course, the gas engine is generally chosen for its simplicity and allowed to run unattended, requiring the services of one man for only part of the day. If the water supply is very bad and impossible to treat properly for boilers, the gas engine should be used and a closed water system installed and treated water used as needed. The quality of the cooling water for gas engines is not so exacting as steam boilers.

The auxiliary machinery, for furnishing cooling water, light, compressed air and any other power required, should be of the high speed direct connected type and the use of belts eliminated entirely if possible.

Hot Discharge Line

A very important part of a station handling large volumes of high pressure gas is the gas piping and particularly the hot discharge line, which is subject to a great deal of expansion and contraction. Provision should, therefore, be made for the free movement of this line until after the gas leaves the cooling coils. To permit this and the possibility of the line being too rigid, an expansion joint of approved type should be placed between each compressor and the main header. Both suction and discharge pipe work should be made of steel fittings and vanstone pipe flanges. This construction consists of a flange rolled on the end of each joint of pipe and pulled together, face to face, with a separate set of steel flanges. Greater strength and less chance of leakage are typical of this construction.

Safety valves should be placed between the first valve on the discharge line and the compressor for safety in starting should this gate be closed or the line frozen shut ahead of the gas cooler. If placed inside the pump house the outlet should be piped outside for safety. A closed or nested type cooler could be placed on the compressor cylinder outlet and the gas cooled immediately, but this type of cooler is not the most efficient and requires considerable pipe work to install. This entire discharge line should, if possible, be laid in a concrete conduit immersed in flowing water. About 50 per cent of the gas cooling may be accomplished before reaching the main gas cooler on account of the large temperature difference between the water and hot gas.

Cooling the Gas

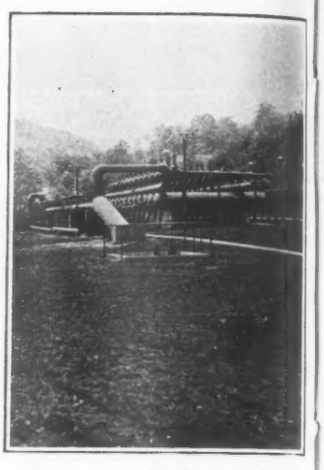
The final cooling of the gas is accomplished in the coolers designed for this work. As the temperature of the gas approaches the temperature of the cooling water the process of cooling slows up and requires an intimate contact of water and gas through the pipe as the temperature transfer medium. The atmospheric counter flow cooler is used extensively for this work. While it costs slightly more than the nested type, less cooling water and repairs are required. After the pipe leaves the cooler it is safe to bury it in the ground as is the practice with the cool suction lines. If a gasoline plant is treating the gas, from the outlet of the cooler, it is recommended, for good gasoline extraction, to provide an efficient cooler and a modern liquid remover to take out any oil or water which would otherwise injure the efficiency of the absorbing medium of the plant.

On the suction lines, it is considered a good investment to install some sort of gas scrubbers for catching any sand or dirt which often contaminates the gas from the field. The sand causes excessive compressor cylinder wear and the dirt injures the compressor valves, causing leakage and inefficiency. This is particularly true on the plate valve type of compressor.

An important feature of a compressing station is the system provided for keeping the machinery lubricated. An overhead tank with gauge glass and capacity of several barrels is generally placed overhead so that sufficient pressure is obtained to allow the oil to flow by gravity over all the engine bearings through brass pipes. It is then collected by another system of similar pipes and pumped to a separator, where the oil is heated and separated from the water, if present, and then passed through filters, where it is again pumped into the overhead tank. This insures good lubrication and saves labor. The cylinders are, of course, oiled by forced feed lubricators, operated by the engines themselves.

There are various types of buildings used for compressing stations. The more permanent construction is of brick or tile with slate or sheet iron roof. These buildings require less heat and no outside paint and are, of course, fireproof. The other types are steel building throughout, or a combination wood and steel building. The building of entire steel is probably the most favored at the present time. It may be purchased completely fabricated, being easily assembled or torn down and moved to another location. The total weight of such a building is less than any of the above-mentioned and is well adapted for the installation of a traveling crane. For large machinery a crane should always be included as it will more than pay for itself in the erection of the machinery. Ventilation should be carefully provided to carry off gas leakage from the building. Various heating systems have been used, although in a station operating constantly a great deal of heat is given off from the compressors and engines themselves. The exhaust heat from gas engines may be utilized with steam or hot water for emergencies, or steam heat alone used. Plenty of windows for good light and well-placed electric lamps, in vapor-proof globes, are well to consider. The floors should be of tile or concrete and covered with floor paint to prevent penetration by oil and ease in cleaning.

NATURAL GASOLINE PLANT



Absorbers at the plant are shown.

Recording Instruments

To insure economical operation of large stations, recording instruments should be depended upon rather than the judgment of the men operating the plant. By the use of these instruments a condensed story of the day's operation may be placed before the superintendent and any equipment out of step can be quickly detected and corrected. Orifice meters should be installed to measure all gas pumped or used for fuel and steam meters for measuring the steam generated. On coal-fired plants the coal should be weighed and a modern system of boiler house control installed. This consists of a master valve, operated by the steam pressure, which controls all the apparatus which fires the boilers, such as stokers, fans, dampers, etc., thus insuring an almost constant steam pressure with the maximum efficiency. In this way a large boiler house may be operated by one or two men and their duties made comparatively simple by the use of automatic machinery.

Regardless of the type of station or machinery used there is something more important to consider than the machinery alone, and that is the men who are going to operate the plant. Efficient machinery requires high-class men and those who have had charge of compressing stations for a gas company appreciate this fact more than anyone else. Good men are hard to get in isolated places and results demanded by large gas companies of today mean that great care should be exercised in selecting a crew for a gas compressing station.

Try Them!

MOST people think that any old bull plug or swaged nipple will serve the purpose, and so they will . . . after a fashion.

But to serve that purpose in the best manner possible your bull plugs and swaged nipples must be of the best quality materials to stand the gaff of tough usage, must be accurately and carefully threaded, and must be low enough in price to keep the cost department in a good humor.

Texas Steel products, rigidly inspected and promptly delivered, meet all these requirements and then some.

Any size or thread.
Try Them!

TEXAS STEEL CO.
ELECTRIC STEEL MAKERS, ROLLERS AND FINISHERS
FORT WORTH, TEXAS

INTER-OFFICE CORRESPONDENCE

Ford, Bacon & Davis, Inc.
Engineers

SUBJECT

New York, June 1, 1927.
DATE

FOR THE ATTENTION OF
MR. J. E. Judson, V.P.

Can you point out in your advertising the wide range of our service in connection with natural gas projects, particularly pipe line construction? Indicate our experience in building lines through country of every character including all sorts of natural hazards: swamps, mountains, rivers, quicksands and under adverse soil conditions. Mention the layout of gathering lines and location of drilling program to reduce field line changes and offset well costs. Call attention to our studies in connection with the use of steam and electric centrifugal gas boosters for the transmission of large quantities of gas over great distances. Mention our experience in the design, construction and operation of economical distribution systems and our studies in connection with pipe deterioration and pipe protection. I think the public is generally familiar with our derivation of scientific rates and probably knows of our broad acquaintance with financial houses interested in natural gas properties, but may not know of our development of industrial and domestic gas markets.

Dict. by Wm. von Phul, Pres.

use this for copy- It tells the story
J.E.J.

Ford, Bacon & Davis
Incorporated
Engineers
115 BROADWAY, NEW YORK
CHICAGO PHILADELPHIA MONROE, LA. NEW ORLEANS SAN FRANCISCO

And Then the 20-Inch Line Blew Out

With Temperature 5 Above Zero and Pittsburgh Needing 60,000,000 Feet. Repaired in 45 Minutes. Real Service

By John B. Tonkin
Vice President, Peoples Natural Gas Co.

Five above zero is cold weather for Pittsburgh.

That's what it was at 8:00 o'clock on the morning of December 18, 1926.

Things were looking good for the Peoples Natural Gas Co. The Brave Compressing Station, largest in the system and second largest in the world, was packing up the 20-inch main supply line and gas was scooting Pittsburghward at the rate of 60,000,000 feet a day.

Back in the boiler room at Brave things were humming. Every available ounce of steam in 15 boilers supplying 18,000 engine horsepower had been built up in preparation for the continuation of the heavy consumer drag just then nearing peak.

Twelve giant compressors were going full tilt so that Pittsburgh consumers, 60 miles away, would have plenty of fuel. The pressure chart read within a hair of 300 pounds as the 8:00 a. m. curve was reached.

Then the 20-inch line blew up!

And for 45 of the most active minutes which the Peoples' personnel ever experienced there occurred one of the prettiest demonstrations of team work and all-around head-work ever witnessed. Field men, pressure men, pipe liners and repairmen all shared honors at the end of the day.

It was a day full of dramatic effort, rapid fire thinking, chance-taking and courageous direction for those in authority. Employes scattered along the 2,600 miles of Peoples' pipe lines all tasted the excitement as word of the explosion spread and orders came for them to man their posts and stand ready for action.

First news of the break came from a line walker some 40 miles away from the spot of the explosion. He was taking a squint at a regulator chart at some isolated spot along his route when he noticed the pressure chart was doing a veritable nose dive. He grabbed the telephone at his reporting box and quickly told the Wilkinsburg Pressure Control Station for the entire system that something was wrong with the "20-inch."

In a flash Wilkinsburg had Waynesburg, Field Division Headquarters, on the wire. Attempts were made to get the Brave station over the company's phone system, but the line was out of commission. It later developed that when the line blew, the bursting joint carried the telephone wires with it.

Shortly after the line-walker had noticed the drop in pressure, the pressure chief at Brave saw his chart taking a perpendicular skid. At first he thought some of the compressors had shut down, but immediately decided to investigate. Finding all engines tearing away at top speed, he sensed disaster.

At Waynesburg two gangs of men started out in the direction of Brave to find the break. They "guessed" it was somewhere in the 17 miles between the two places. Following them were repair trucks filled with men, emergency equipment and tools.

Excitement at Brave

Back at Brave again. Things were popping fast. No telephone . . . . . boilers were under full steam . . . . . as quickly as possible all compressors were shut off . . . . . relieved of their load, the boilers—15 of them—started spouting steam at a terrific rate . . . . . the pop valves were shrieking and howling. Townspeople of Brave—relatives of men in the station—were in a high state of excitement for a few minutes. But boilermen and all of the crew handled the situation to perfection and gradually lessened steam pressure until a point of safety was reached.

Considering the impassable condition of the ice covered dirt roads that had to be traveled, plus the extremely rough and hilly section through which the Peoples' line travels from Brave to Waynesburg and thence north to Pittsburgh, one crew that had set out from Waynesburg found the break in an incredibly short time.

J. L. Ridgway and Joe Chilcote, division foreman, reached the spot first.

They found a roaring tower of flame shooting from the broken line. No wonder, for gas was pouring out of both ends of the break at the rate of approximately 6,000,000 feet an hour.

Later they discovered the blown joint. It had ripped at the weld which was at the bottom of the trench. The pressure had forced this 1,200-pound piece of pipe up through 6 feet of earth and catapulted it to a point more than 200 feet away.

Once on the spot, a knowledge of the location of lines and gates that comes with years of experience in the field—helped Ridgway and Chilcote to complete their splendid job. The foreman hurried to a gate which was about 2 miles away from the break. Chilcote started out for another, 6 miles to the north. With the gates closed, the fire soon ceased; and meantime Brave station had been reached via rural telephone lines, and the whole Waynesburg Field was aroused to action.

Service in 45 Minutes

Orders were relayed to Brave to start pumping into the 12-inch low pressure line which parallels the 20-inch. Ridgway and Chilcote had manipulated their gates some 8 miles apart to form a by-pass around the broken section.

In 45 minutes from the moment the break occurred, and probably within 30 to 35 minutes after it was discovered, Brave again was building up pressure via the 12-inch line. By midnight the line had been fully repaired with a new joint and the gas was routed as usual.

But the story doesn't end here.

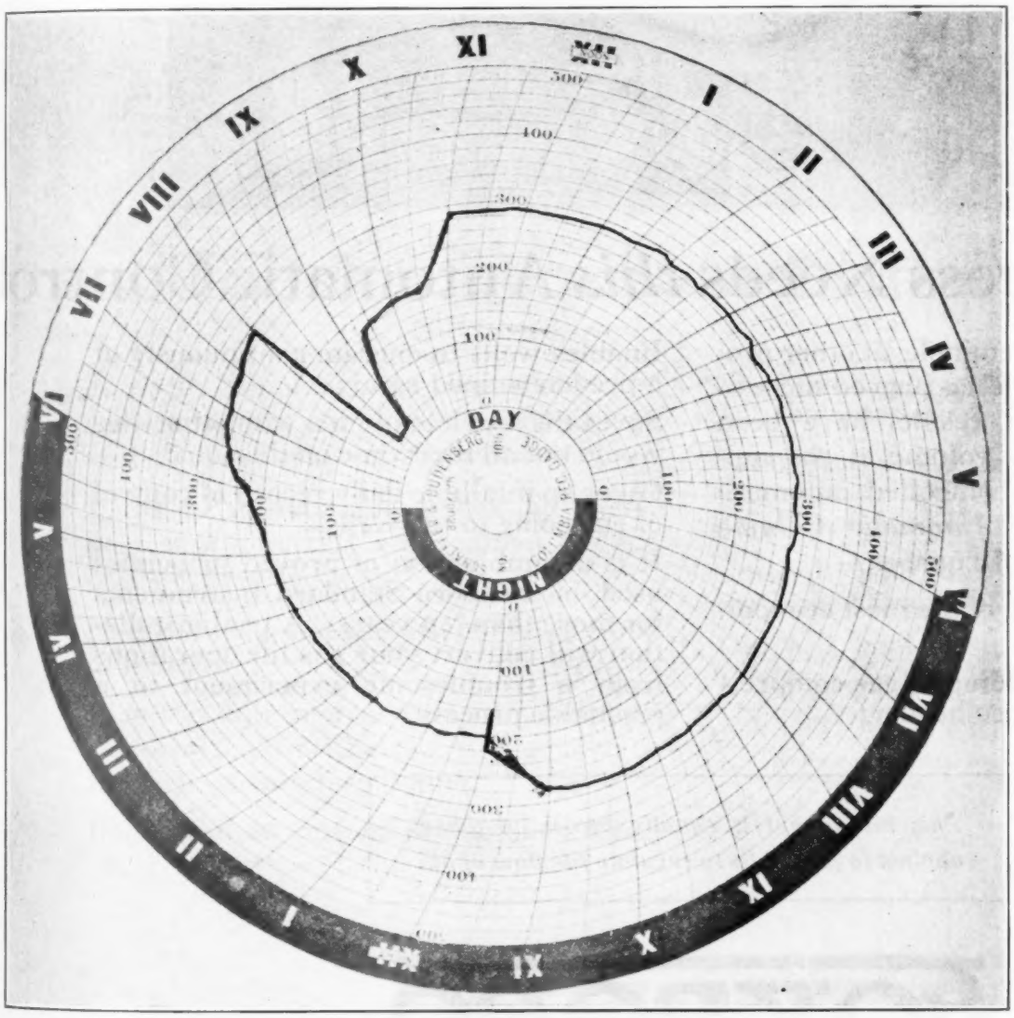
When pressures began to sink, it seemed inevitable that consumers would suffer, since the main supply had temporarily "gone on the fritz." Every one was on the job and plunged in to set matters aright. In a jiffy plans of action were determined and to Ross Gray fell the job of getting all possible gas routed to Pittsburgh from points north and east. And it's no small job to gather gas from a territory covering square miles—especially on a day when every section is using practically all it can get.

Gray soon had all compressor stations to the north pounding away in full, passing every available spare foot of gas to Pittsburgh via McKeesport, third largest station in the system.

Orders were dispatched to have field men rush to a group of high pressure wells in the Donohue Field, some 30 miles to the east of the city, and turn them in. These wells poured into the lines at 1,500 pounds pressure.

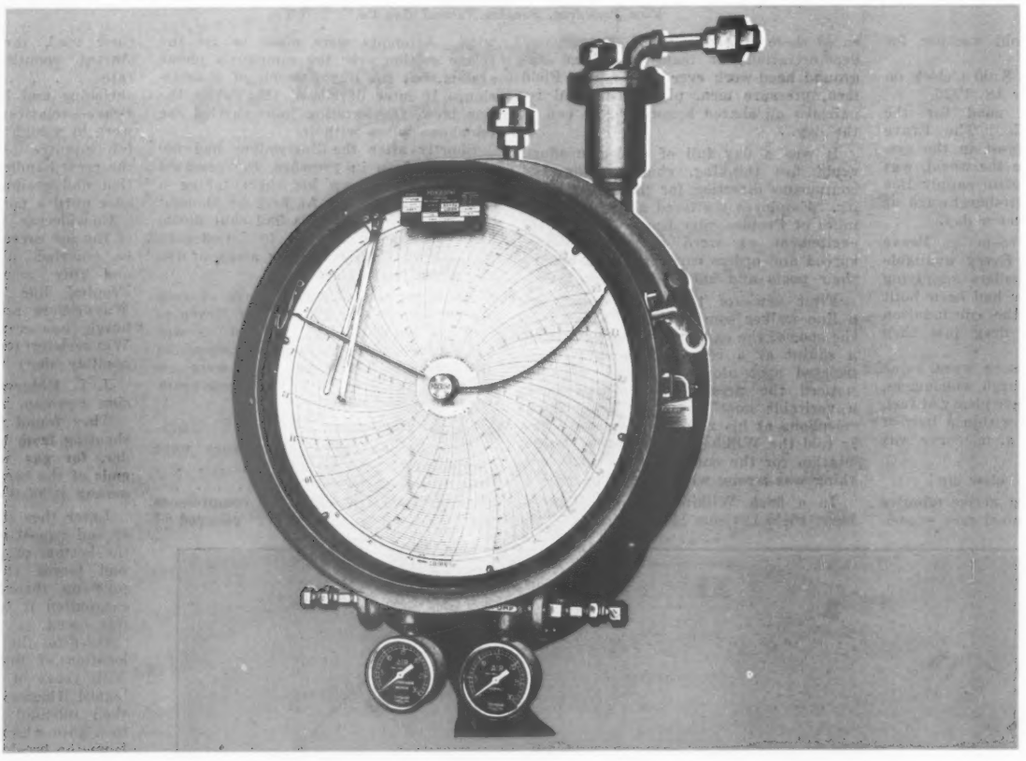
Industrial Shut Off

Industrial consumers were told to stand by. Their supply was shut off to further safeguard the domestic supply. At Altoona the easternmost point of the line,



The abrupt drop in the pressure line beginning on the dot of 8 a. m. as shown on the chart above graphically tells the story of the break in the main 20-inch line of the Peoples Natural Gas Company of Pittsburgh when it occurred last December 18. For 15 minutes the pressure skidded downward, halted at 30 pounds while frantic efforts were being made to find the blowout. Exactly 45 minutes after the explosion took place, the break had been found, gas by-passed around it, pressure again was on the upgrade and what threatened to be a serious consumer shortage was miraculously averted.

The Finest Line of Instruments Ever Of



Gas Lift Process Needs *this* Automatic Control

At Dominguez, at Seminole, at other producing fields Gas Lift has proved successful. And the best results have been achieved where the volume of gas supplied each well is controlled automatically by a *Foxboro Automatic Volume Controller*. This Instrument:—

Permits establishing of the most economical Oil-Gas Ratio;

Permits the manifolding of gas compressors into a single large header;

Enables wells to operate continuously at a predetermined rate;

Saves the services of men who otherwise would put all their time on this job;

Gives an infallible daily record of control of gas going to the wells.

It is a combination of proved principles used in Foxboro Standard Instruments for more than ten years. A trial installation will convert your gas lift operations from a troublesome experiment to a profitable process.

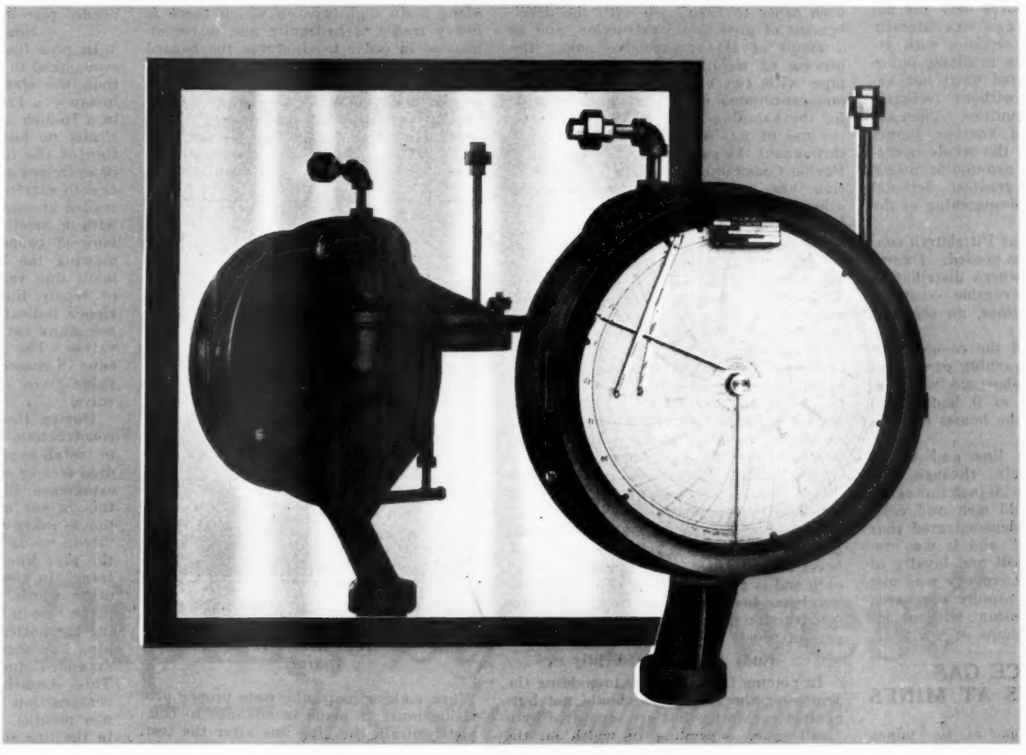
This instrument is equally successful when applied to pipe stills to regulate the flow of oil.

FOXBORO

REG. U. S. PAT. OFF.

THE COMPASS OF INDUSTRY

Offered to the Oil and Gas Industry



The *New* Foxboro Orifice Meter

Strength, Simplicity and Dependable Accuracy are the dominant characteristics of the New Foxboro Orifice Meter.

It can be cleaned and assembled in the field easily, quickly and without danger of disturbing accuracy.

Its accuracy is not affected by the amount of mercury.

It is the only meter with an absolutely uniform scale of the chart—a great advantage when interpolating.

It is the most powerfully actuated float type meter on the market. Note the 3¼ inch diameter machined steel float.

This meter is inherently accurate. Accuracy means PERMANENT ACCURACY. It can't be anything else but.

Uniform Multiplication makes this improvement possible.

You will want to study this meter carefully.

THE FOXBORO CO., *Inc.*
Neponset Avenue, Foxboro, Mass., U. S. A.
205 So. Cheyenne Ave., Tulsa, Okla.
NEW YORK CHICAGO BOSTON PHILADELPHIA PITTSBURGH
CLEVELAND ROCHESTER ATLANTA LOS ANGELES
DETROIT SAN FRANCISCO PORTLAND, ORE.

FOXBORO
Reg. U. S. Pat. Off.
THE COMPASS OF INDUSTRY

a 1,000,000-foot gas holder helped out in great fashion.

While all this was going on, Brave Station was building up pressure as rapidly as possible, but the drag against it was heavy. In a half hour after starting again the Brave pressure showed 200 pounds, but little of this gas had yet reached Pittsburgh.

Pressure men sat at the Wilkinsburg Control Station, just outside the city limits, with eyes glued to gauges that told the story of pressures over the entire system. In turn gas was literally snatched from various sections with remarkable finesse. Every available ounce of pressure was extracted until not another could be taken without seriously endangering other communities. Then another and another and another supply division was called on, the whole operation being timed to an astounding nicety that rivals even the greatest fictional feats of intricate train despatching of the most romantic sort.

The net result was that Pittsburgh consumers had the gas they needed. Except in isolated instances, where distribution conditions were not favorable—such as "dead ends" of street lines, no shortage complaints were heard.

The company secured the co-operation of the newspapers in warning consumers that possibility of a shortage was imminent, but all danger of it had passed before papers reached the homes of most of the consumers.

In the field a pipe line and repair crew toiled unceasingly through the rough weather until the 20-inch line again was in operation. Field men and compressor crews as well demonstrated that they "knew their stuff" and it was undoubtedly due to the skill and loyalty of all the men that the emergency was met so readily and was so rapidly conquered without the least confusion, without injuries, accidents or mishaps of any kind.

WOULD PRODUCE GAS IN PLANTS AT MINES

Production of coal gas at the mines from cheaper grades of coal, and pipe line methods of distribution, bringing cheaper prices to the consumer, are predicted by F. C. Greene, carbonizing engineer of the Old Ben Coal Corp., Chicago.

Mr. Greene appealed for co-operation between coal and gas companies, and said the greatest need was for the production of gas at the mines instead of in cities where used. He said the cost of gas was determined by the quality of coal used in making gas in cities, and was further increased by the cost of transportation.

He said that if both interests co-operated and moved their plants to the mines they would find supplies of low-grade bituminous available for making gas at a cost 5 per cent less than the high grades of bituminous now used. Machinery would have to be designed to use the lower grades.

Mr. Greene described a new kind of smokeless fuel, which he called "coalatem," and said it was made by extracting tar from cheap bituminous. While it is not used generally now, he believed smokeless fuel would be used more generally in the next five years.

HEATING VALUE OF WATER GAS

Prof. D. J. Demarest of Ohio State University announces that he has conducted experiments which resulted in the discovery that the heating value of water gas may be increased from 25 to 30 per cent by passing the gas over "activated" and heated coke. He said the discovery would probably result in the substitution of coke and coal for petroleum, which is used in making water gas.

GAS INDUSTRY COUPLINGS

Couplings for natural gas pipe lines are an important factor in the transportation of natural gas. Three makes of couplings are used by the industry, the Dresser and Dayton makes being the oldest on the market while the Victaulic has been introduced in comparatively recent years.

Pipeline Construction in California

Policy of Welding Joints of Plain End Pipe Into One Continuous String Has Been Adopted on Pacific Coast

By William Moeller, Jr.
General Manager, Midway Gas Co., Los Angeles, Calif.

California pipe line companies have been eager to keep pace with the development of pipe line construction, and as a result of this progressive policy the process of welding joints of plain end pipe with the oxy-acetylene torch into one continuous string has been adopted for the handling of oil and gas. In fact, the use of welded pipe lines has spread throughout the gas industry on the entire Pacific Coast until this type of construction has practically superseded every other type on lines larger than 2 inches in diameter.

California was a pioneer in welded construction. The first welded gas line, to the writer's knowledge, was laid at San Francisco in 1915 by the Pacific Gas & Electric Co. to supply gas to the Panama-Pacific fair grounds. This was a low pressure distributing system. Later in that year the first welded high pressure natural gas transmission line was laid by the Midway Gas Co. at Los Angeles. This was an 8-inch line about 15 miles in length, operating at 250 pounds initial pressure, and supplied natural gas from Coyote Hills Field to Los Angeles. This line is still in operation and has rendered practically perfect service.

Plain end lap weld Bessemer or open hearth steel pipe having a 45-degree bevel and about $\frac{1}{16}$-inch straight face at each end is generally used. The 45-degree bevel has been found to result in better construction than a greater or lesser degree of bevel.

Ends Separated Slightly

In placing the pipe prior to welding the joints together, the ends should not butt against each other but are separated by a small space depending in width on the size of pipe and thickness of the pipe wall. To insure good work, it is essential that good welding material and experienced welders be used and that the work be rigidly inspected. A plan that requires each welder to mark his work with an identification mark will tend toward better workmanship. Paying welders on the basis of the number of welds made each day is not recommended.

It is needless to say that trenching and backfilling is performed by modern trenching and backfilling machines, where conditions permit their use.

The common method of testing during construction is to isolate or blank off sections 1 mile or less, as conditions permit, after these sections are welded together, painted, and are on the skid over the trench ready to be "lowered in." These sections are then subjected to 100 pounds air pressure from a portable air compressor, and inspected for leaks. A pressure record is obtained on a recording pressure gauge attached to the section under test. This test is a preliminary test and must show no loss in pressure over a 10-hour period, making proper allowance for change in temperature of air in the pipe during such test.

In case wrapped pipe is used, this preliminary test is made before the welds are painted and wrapped, in order to facilitate inspection during the test.

Pressure Tests Taken

Following the preliminary test, construction work is completed and a final pressure test is made to determine that the line is tight. A recording pressure gauge is attached to the line and provides a record of such test. The length of the test is actually 24 hours, during which time there must be no loss in pressure, making allowance for any temperature change of the medium inside the pipe line. The pressure applied in the final test should be the maximum working pressure under which the pipe line will operate. It is not recommended that test pressures exceed the maximum working pressure of the line.

Where high pressure pipe lines are laid along main highways on which there is heavy traffic, a hydraulic test is recommended in order to eliminate the hazard should a failure occur if high pressure air or gas were used to make the test. Water is supplied by means of a high pressure two-stage portable pump. Pressures as high as 500 pounds for gas lines and 1,200 pounds for gasoline lines have been safely used in such hydraulic tests.

A 16-inch welded line ready to be lowered. Light color of line due to reflection from fresh paint.

When making hydraulic tests proper provision must be made in advance to completely drain the pipe line after the test, where the line is used for gas.

Protection From Corrosion

The matter of pipe protection against soil corrosion has been given much study, and it is recommended that a survey of soil conditions along the proposed right of way of a pipe line be made in advance in order to intelligently determine the kind of protection that should be provided on the various sections of a given line. It is not economical to use expensive protective coatings in soil that is not corrosive, and it is poor economy to use inferior protective coatings in soils that are highly corrosive. It is our experience that men trained in soil analysis through careful observation of the effects of various soil conditions can prepare a good schedule of protective coverings to be used on any given pipe line. In ordinary noncorrosive soil, one or two coats of coal tar base paint, applied cold in the field, will afford proper protection. In highly corrosive soils, the best protection must be provided, such as a machine wrapped job using a priming coat after thoroughly cleaning the pipe, then a coat of asphalt applied hot over which a heavy waterproof felt is wrapped spirally by machine. Additional coats of hot asphalt and wrapped felt should be applied if conditions demand. It is usually more convenient to apply a wrapped covering in the "shop" rather than in the "field," in which case the ends of each joint are left exposed for welding, and it becomes necessary to treat and wrap each weld in the "field" after preliminary test is made and before the line is lowered into the trench.

Owing to the uncertain behavior of our rivers and streams, experience has taught us that pipe line crossings in a river bed are not always safe, and there is a growing tendency toward the suspended crossing made by erecting a tower on each bank of a stream and securing the pipe line to a pair of steal cables suspended from these towers, and anchored back from the bank of the stream. Two cables, placed some distance apart, should be used to prevent swinging of the suspended pipe line.

Smaller Valves Used

In pipe lines of larger diameter, it is economical to use valves of a smaller size than the size of the pipe line, as, for instance, a 12-inch valve may be installed in a 16-inch high pressure line with practically no loss in pressure in the operation of the line. Good judgment should be exercised so as not to carry this practice to extremes. A small by-pass is installed around all large main line valves with a small valve at each end and a blow-off connection between to facilitate blowing the line on either side of the main line valve when this is necessary to repair line breaks or leaks. Experience indicates that it is better to use too many rather than too few main line valves. The loss of gas, time and revenue in case of line break may exceed in value many times the cost of the extra valve.

During the early days of welded line construction, it was considered necessary to install expansion joints every few hundred feet or so along a pipe line, but our experience in California indicates that this is not necessary, if proper precaution is taken during construction to make "tie-in welds" early in the morning when the pipe line is "cold," and to refill the trench in the early part of the day. In other words, it is not good practice to make "tie-in welds," to refill trench during the hottest part of the day when the pipe line sections have been heated and expanded due to exposure to the sun. This condition applies particularly to construction carried on during the summer months. Liberal allowance for slack in the line should also be made.

An expansion joint (long sleeve coupler) should be installed on one side of

Construction of an 8-inch welded gas line in Elk Hills Field, Calif. Gasoline absorption plant in background.

each main line valve and at such places as railroad or bridge crossings in order to eliminate the possibility of failure due to excessive contractional strains at such points. Where such expansion joints are used, clamps and tie rods should be installed to prevent the pipe from pulling out of the sleeve (tie rods should be long enough to permit the expansion joint to function properly).

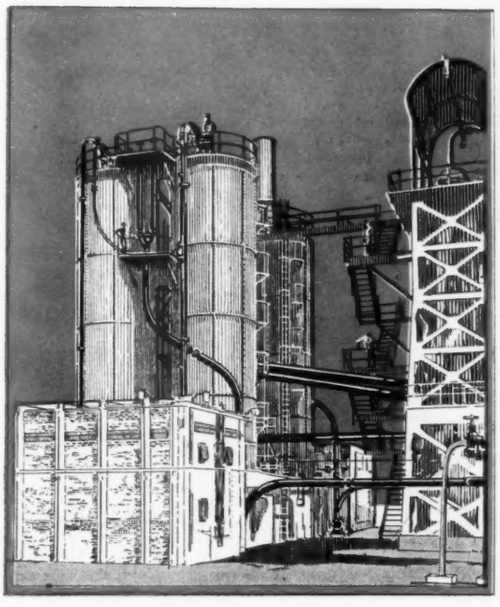
Angle welds in pipe line construction should be limited to 45-degree maximum. If a 90-degree angle must be made in the line, use two 45-degree angle welds rather than one 90-degree angle weld.

Welded steel pipe lines are now in use generally in the oil industry in California for transportation of oil under pressure as high as 800 pounds, and quite recently a 4-inch steel welded line approximately 100 miles in length was placed in service for the transportation of gasoline.

LET THERE BE LIGHT

Flapper: "I'd like to try on that red dress in the window."

Salesman: "Sorry, Miss. That's a lamp shade."



"Piping *by* Midwest"
--- it's significance

WHEN you place your order for "Piping by Midwest," you rely upon a company that has the facilities and organization to do the work quickly and efficiently, whether it be a small coil, a carload of bends and headers, or all the fabricated piping required for a large oil refinery.

You are assured prompt attention, intelligent interpretation of drawings and specifications, and fabrication in accordance with the most modern practices. Each order is the most important order in the shop—that is the Midwest attitude.

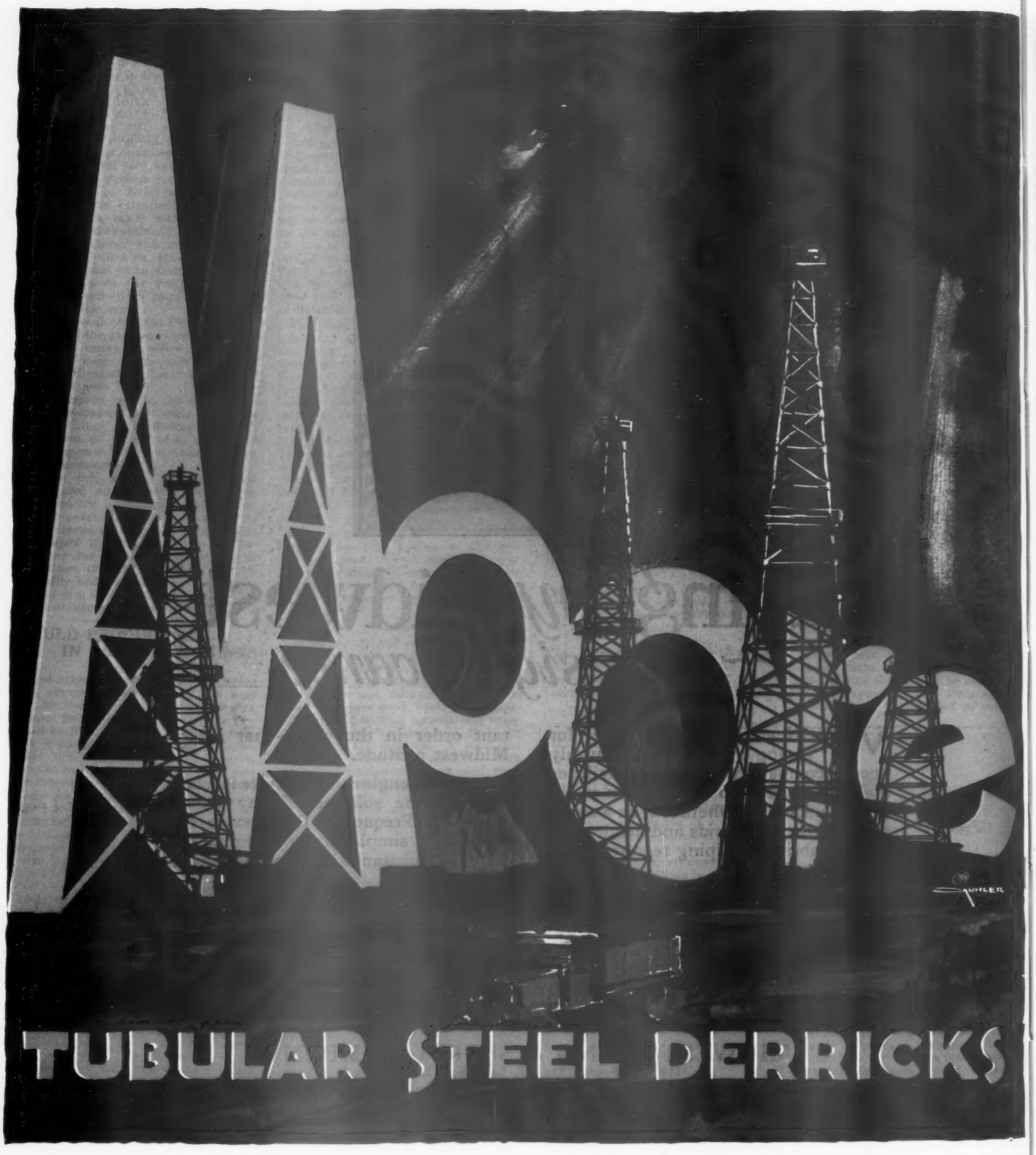
Competent engineering service is available for the solution of any piping problem. Frequently this service has resulted in simplification of piping design and substantial cost reductions.

You are benefiting by the experiences of an organization that has made definite contributions to the development of refinery piping, and is habitually alert for opportunities to better serve the users of fabricated piping.

Bulletin S-5 will tell you more about Midwest Piping Service.

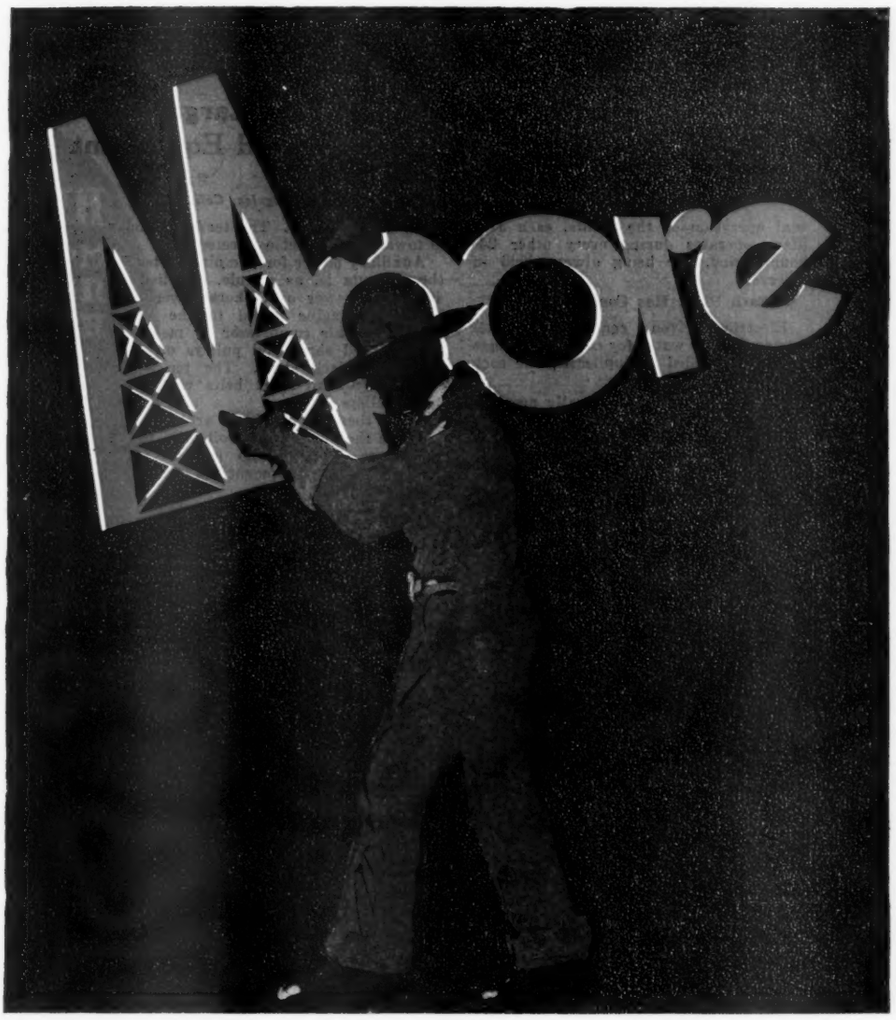
MIDWEST PIPING & SUPPLY COMPANY
1400 So. Second St., ST. LOUIS, MISSOURI
Chicago Office: 208 S. La Salle St. Tulsa Office: 805 Mayo Bldg.
Fabricators of Oil Refinery, Natural Gasoline Plant and Power Piping

MIDWEST Piping Service



STRONG · PORTABLE · ECONOMICAL · DEPENDABLE

"World Wide Service for Twenty Years"



A DERRICK to be truly economical must deliver long years of continuous service—must be used again and again, in one location after another—must have light weight with great strength—must be simple to erect and to dismantle—must be easy to transport from place to place. Here the Moore Tubular Steel Derrick has no equal.

LEE C. MOORE & CO., *Inc.* PITTSBURGH · TULSA

Established 1907

DALLAS, TEXAS HOUSTON, TEXAS WICHITA FALLS, TEXAS BORGER, TEXAS PARKERSBURG, W. VA.
CASPER, WYO. SHREVEPORT, LA. EL DORADO, KAN. EL DORADO, ARK.

California Compressor Installation

Rapid Development of Oil Fields Making Large Quantities of Gas Available Forced Standardized Equipment

By E. Henderson
Superintendent Southern Division, Midway Gas Co., Los Angeles, Calif.

The natural gas business in California is influenced in a large measure by the development of the oil industry, by reason of the fact that most of our gas comes from oil wells. With the rapid development of the oil business during the past few years, the large quantities of gas made available required rapid installation of gas compressor facilities in order to make this gas available for high pressure transmission lines.

This peculiar condition called for standardized construction, so that compressor facilities could be readily moved from one field to another, construction work rapidly completed, and units readily added or removed as occasion demanded with as little interference as possible in the operation of these plants.

Midway Gas Co.'s compressor installation in Dominguez Field.

Field Gathering Plants

Owing to the intensive development of many of the California fields, due to small land holdings and competitive drilling, a minimum of ground space is usually available for compressor plant sites. As a result of this condition, the majority of our compressor installations are made up of 3 to 24 units of 150 horsepower or 200 horsepower each. These plants are scattered throughout the various oil fields, and for convenience will be termed "field gathering plants."

In addition to these "field plants," there are several main line plants made up of 500-700-horsepower and 1,000-horsepower units; the largest containing nine 750-horsepower units. The compressor units in these large main line plants are four cycle horizontal twin tandem and, in some cases, single tandem gas engines, direct connected to compressor cylinders. The compressor cylinders in every case are connected to the main frames on the opposite side of the crank shaft from the power cylinders.

The auxiliary power for operating water pump, shop equipment and for light is electric current, generated by auxiliary gas engines, direct connected to generators. In one instance, 220-volt "D C" current is used, and in another 440-volt "A C" current is used. Each auxiliary engine is connected to an air compressor through a cut-off clutch on the end of the generator shaft. The air compressor furnishes high pressure air for starting the large gas engines. The auxiliary units are in duplicate, each one capable of supplying all the power needed. In actual operation of the plants, each auxiliary operates during every other 24-hour period, one being always held in reserve.

Each Plant Has Complete Shop

Electric driven centrifugal water pumps furnish water for cooling purposes and are installed in duplicate; one each for reserve.

Each large plant is generally provided with a complete shop, which contains a large and a small lathe, a radial-drill, a shaper, a grinder, miscellaneous hand tools, and welding and blacksmith equipment. A shop of this type handles the repair work necessary for the maintenance of the large plant, and also takes care of major repairs to small plants, field and pipe line maintenance work.

The compressor, auxiliary, shop and pump buildings for large main line plants are of steel construction with corrugated iron siding and roof, well ventilated and lighted. The larger buildings are provided with cranes and hoists to facilitate handling engine parts, etc.

The "field gathering plants" consist of 150-horsepower to 200-horsepower gas engine power units, either direct connected to compressor cylinders or belt connected through short belts and idlers to belt-driven compressors. The tendency today is toward the direct connected unit.

Auxiliary power for pumping water for these plants is, as a rule, supplied by 40-60-horsepower or 80-horsepower auxiliary gas engine belted to the water pumps and air compressor by means of an extended shaft and pulleys or through a jack shaft. The tendency is toward short belts with idler pulleys.

Since these small plants are located in the fields where "oil field" shops are available, no machine shop equipment is installed.

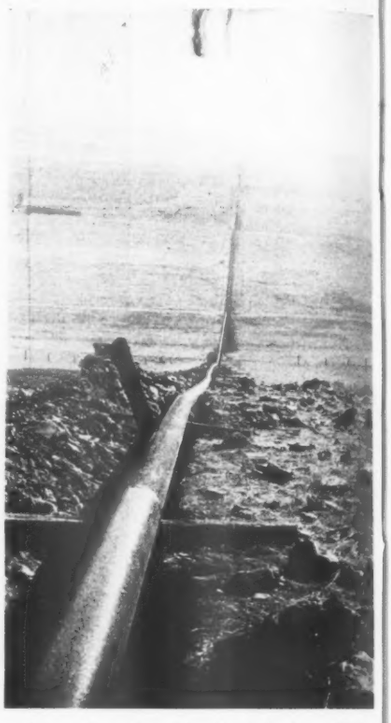
While some operators still adhere to wooden compressor building construction for the "field gathering plants," the majority of these plants have steel buildings with corrugated galvanized siding and roof construction, well ventilated and lighted. Auxiliary buildings and smaller buildings are usually wood frame and corrugated iron.

Standardized

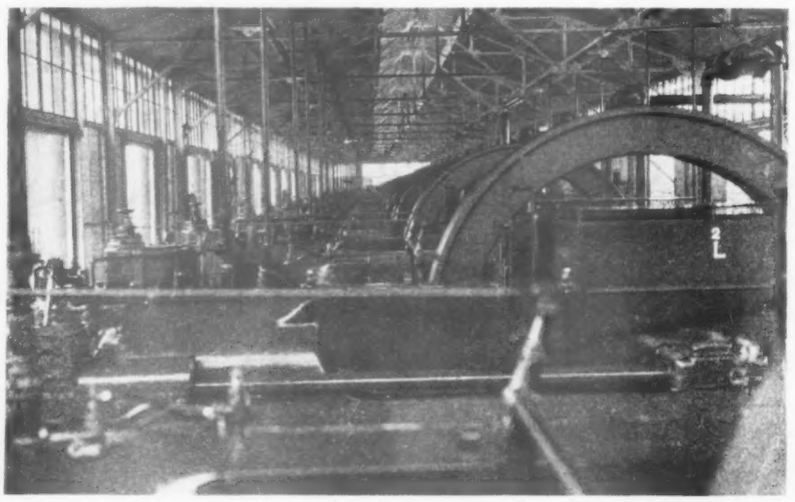
In order that units may be readily added to or removed from these field gathering plants, the construction has been standardized in a large degree. Each main compressor unit has its single bay of building, and each unit has standard engine and compressor piping. The tendency is to adopt one type of unit for all plants; one type and size of main building, and to standardize the gas intake and discharge header connections.

The water supply available for compressor plants in many of the California fields contains considerable scale-forming salts. In order to prevent excessive scale deposits in the cooling jackets of gas engines, the standard practice is to provide a so-called closed water cooling system at each plant. This system comprises a form of heat exchanger through which the hot water from the engine jackets is circulated, cooled and then returned directly to the engine jacket, completing the cycle. The open type heat exchanger installed in the cooling tower and made up of exposed tubes through which the hot jacket water passes and over which the cooling water in the tower flows, has the advantage of being more accessible.

As a safety measure, in the event of bad leaks or fires in the plant, pressure operated remote control shut-off valves are installed in all gas intake lines to the plant, and automatic stop check valves are installed on the gas discharge lines. Bleeder lines are connected to the various station manifolds, and are connected to a common blow-off stack at some convenient point, at which point is also located the pressure valve which operates the various remote control valves, so that in case of an emergency all the gas coming into the plant may be shut off by the operation of the remote control system, and all gas may be bled from the station piping by opening of the valves at the blow-off stack. The automatic stop check valves in the discharge lines prevent the back flow of high pressure gas.



A section of a 35-mile 8-inch welded gas line recently constructed by the Midway Gas Co.

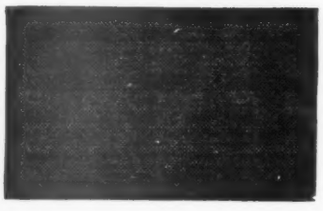


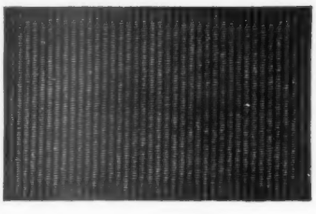
View of 19 direct driven gas compressors of 160 H.P. each at Dominguez.

INDUSTRIAL USES

It is rather surprising to know that 60,000 separate and distinct products owe something to gas in their process of manufacture. Some of the better known of these may be mentioned, such as: vitrous enameling, jappaning, core drying, barrel drying, brick firing, ice cream cones, tempering and hardening, metal melting, coffee roasting, machined steel carbonizing (cost reduced to 1 cent from 6 cents), traveling bake ovens which turn out as many as 5,000 loaves of bread an hour, domestic refrigeration, galvanizing, welding, glass making, lead and silver refining.

$AVING $CREEN WITH BETTER





Special Wire Screens for Absorption Towers for Charcoal Gasoline Recovery

Monel Metal Filter Cloth for Contact Filtration

Retaining Screens for Percolating System of Declorizing

Wire cloth & Filter cloth in All Meshes & All Metals for Every Phase of the Petroleum Industry

In Stock for Quick Shipment

Write for Catalog Samples, & Prices

MULTI METAL CO.

WIRE CLOTH FOR MECHANICAL SEPARATION
FILTRATION ~ EVAPORATION ~ DRYING

807 EAST 139TH STREET, NEW YORK CITY

Millions Annually

OF THE Millions spent annually to produce and distribute the hundreds of billions of cubic feet of natural gas consumed in the United States, we want only such portion as we actually deserve by reason of intelligent service.

This service begins with tools and supplies which may be had at any one of our many stores, and ascends to equipment of such intricate magnitude that details must be negotiated through our engineering department.

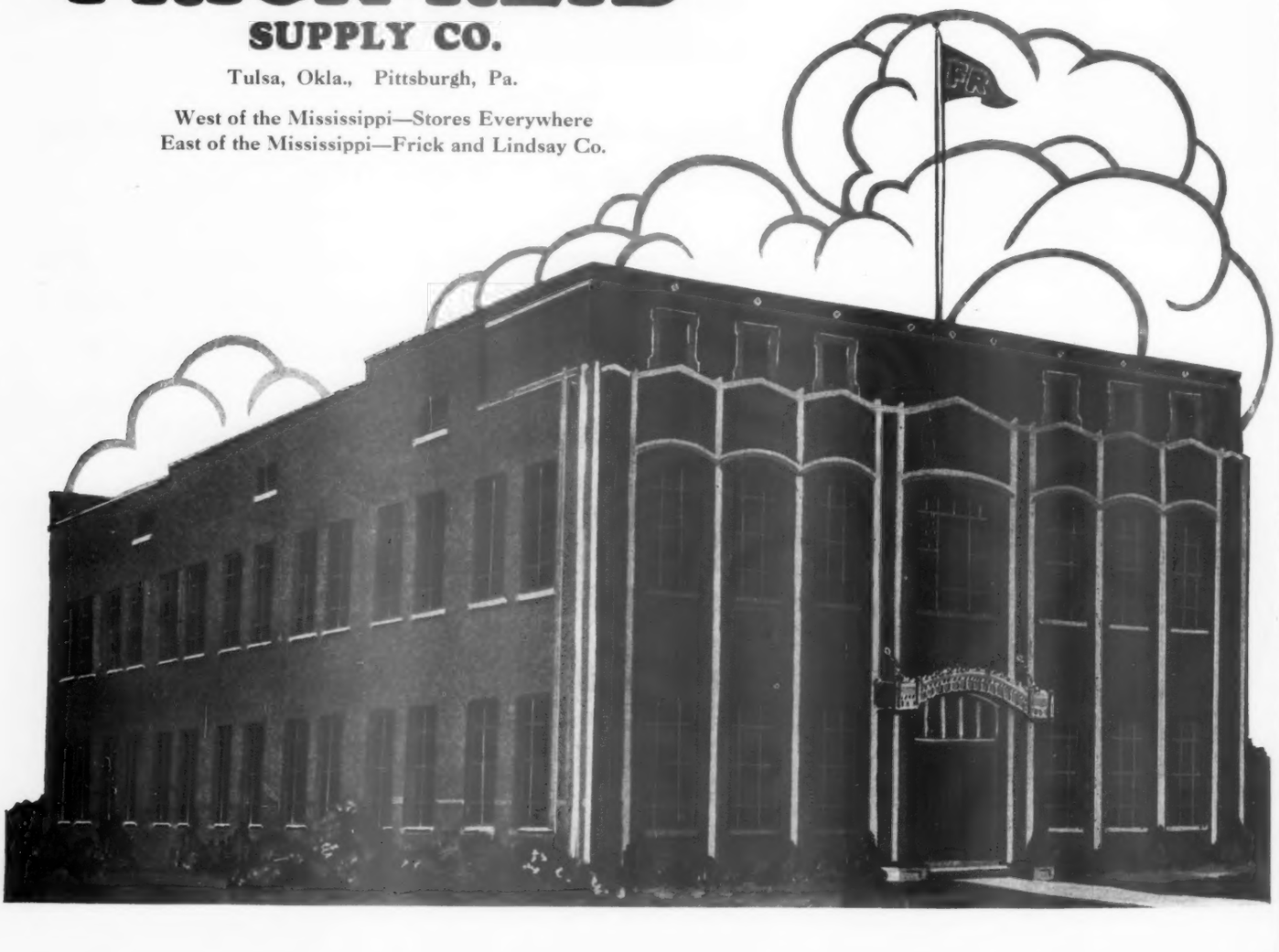
Our vast facilities for pipe shipments are known to all the great companies. A car load or a train load is always immediately available in all standard sizes.

An added link in our strong chain of service is the newly completed general office building illustrated below, situated on our Central Warehouse property, North Trenton Avenue, Tulsa, Okla., where correspondence should be addressed.

FRICK-REID
SUPPLY CO.

Tulsa, Okla., Pittsburgh, Pa.

West of the Mississippi—Stores Everywhere
East of the Mississippi—Frick and Lindsay Co.



What Can Be Done With Natural Gas

There Are Two Problems: How to Dispose of Surplus Above Domestic Needs and How to Get Higher Rates

By Henry O. Loebell
President, The Surface Combustion Co.

What can be done with natural gas? This question appears timely due to the fact that most natural gas situations have an abundant supply for the present and confidence of a large supply for years to come. Of course, the question is not so much what can be done with natural gas as how we can sell as large a quantity as possible at higher rates and establish ourselves more permanently in the service of supplying fuel.

Our business is of a nature where production and consumption are difficult to control. Besides we are confronted with many problems of seasonable demands and we therefore experience similar difficulties to those encountered in the manufactured gas, petroleum, hydroelectric, and other industries.

Two Essential problems

From the standpoint of sales the average natural gas company is confronted with the following two essential problems which deserve detailed study:

1. How to dispose of the surplus gas over and above seasonal requirements of the domestic customer.
2. How to secure a generally higher level of prices for our product.

These problems must be viewed in the light of three elements which materially affect them:

1. Competition as a limiting factor to volume of sales and level of rates.
2. Service as a factor in rate levels.
3. The influence of utilization equipment as a limiting factor of service, rates, and volume of sales.

Obviously the importance of these factors is particularly pertinent to those activities in which the greatest potential load exists, namely: househeating and industrial heating.

Before we attempt to analyze the problems existing in these two major fields of our industry, let us accept two definitions—

1. Primary load—meaning that load which we can take care of 365 days in the year and deliver the quantity and the demand as the customer needs it or wants it.
2. Secondary load—or dump load as it is unfairly called, as being that portion of the load which is available at certain seasons or periods either as a surplus production or as a result of seasonal demands from primary load.

Househeating

It is impossible to say to what extent househeating by gas has been retarded by the lack of good service. From experience, most of our gas troubles are winter peak difficulties. However, this class of load furnishes a large percentage of the revenue the average natural gas company receives per customer. Logically, therefore, it is not desirable to dispense with this load. We must retain it and attempt to adjust its idiosyncrasies to the greatest possible extent.

In order to establish a better understanding of what the gas company should do in order to obtain and retain this business, it may be well to consider past experiences and see if we can learn some facts that will help us solve our problem. We know that it is uneconomical for a natural gas company to provide field and distribution pipe lines to take care of the peak winter demand and then sell its product at a price in competition with other fuels used for the same purpose when such a price will not allow for a fair return on the investment.

In the past a compromise had to be made which was only reluctantly accepted by the public who have been subjected to the inconvenience of having partial service, using dual fuels and equipment, or an insufficient supply during the coldest weather. This type of service has been accepted at a price level which is considerably below that price which can be obtained where the home owner is given continuous and dependable service.

Efforts to Solve Problem

The gas company during periods of shortage has tried to solve the problem by limiting house heating through state or city laws or by increasing the rates for large consumption. While such methods have been partially successful in reducing the load and improving the service, they have not permanently effected a solution because the extent of the peak demand developed or the kind of burner equipment used for house heating has not been under the supervision and control of the gas company.

An important fact that intensifies the difficulty of the problem for the gas company is the existence of house heating equipment of exceptionally low efficiency which not only aggravates the situation from the standpoint of the consumer by increased expense because of poor performance, but considerably endangers the situation from the gas company's standpoint by causing such unnecessarily heavy demands upon the system during periods of peak demand.

It is conservative to state that on the average, many of the installations for house heating use 30 per cent more gas than would be necessary if proper equipment, properly installed, had been in existence. This situation has improved of late and most gas companies are taking effective means to eliminate inefficient equipment but the rate at which these changes are being made is entirely too slow.

What Solution Can Be Offered?

Most people want more and better conveniences in the home. They are willing to pay, within the limits of their income, for automatic house heating. The thousands of oil burner installations made yearly and the new devices to burn coal automatically or at least with less trouble, are proof of the interest the public is taking in this subject.

The cities in which natural gas is now available have at some time in their existence enjoyed an abundance of this fuel and the public has generally accepted its desirability. Hence, sales resistance cannot be very great if assurance of permanent service can be given. Therefore, as a practical consideration of what can be done with natural gas in the field of house heating, the following two suggestions should prove helpful:

1. A careful survey should be made of production and distribution facilities in each community or territorial section to determne definitely the maximum demands that can be supplied under proper pressure conditions to give the customer adequate service at all times. On a basis of being in a position to supply gas without interruption for house heating, a careful analysis should be made of the competitive worth of natural gas with other fuels for house heating and a schedule of rates instituted which will give the company the greatest return from this class of business. In those territories where there is an available supply in excess of maximum consumption, the house heating load can be expanded on a sound, permanent, and profitable basis. In those territories where service is poor because maximum consumption is in excess of available supply, higher gas rates will serve to limit the use of gas for house heating to those homeowners who are willing to pay for a preferred automatic house heating service.

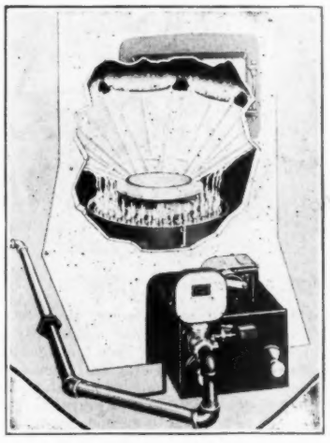


Figure 1

2. All house heating installations should be inspected by qualified engineers and recommendations should be made to increase efficiencies by the use of better utilization equipment. On existing installations the efficiency of operation can often be greatly improved by simple methods of proper baffling, insulation, etc. In many cases it will be found desirable to recommend the installation of a new type of burner and often a new furnace.

It is believed that in most cases such equipment can be sold on a basis where the economies effected will pay for the cost of the equipment in a reasonable period of time. The above measures will be of great benefit to the gas company because the demand per customer will be greatly reduced, less difficulty will be encountered in maintaining adequate pressure conditions and, in many cases, large quantities of gas will be released to be sold for other purposes.

Regarding Equipment

It is the writer's opinion that on this point there is room for a great deal of improvement and while it is preferable that equipment designed specifically for gas be given preference, both from an engineering and practical standpoint, it is possible to convert a solid fuel designed furnace to gas without sacrificing appreciably its efficiency or operating characteristics. Such an equipment is illustrated in Figure 1.

If it appears impracticable, too expensive or untimely to supplement the natural gas supply where necessary with manufactured gas, and the opportunities for the sale of gas for house heating are good but the peak demand limits the opportunity to increase the volume of sales and also the level of rates, then a dual fuel equipment installed under gas company supervision should prove desirable and has an advantage in the fact that the consumer shares the burden of the peak load. The burner automatically takes care of the shortage of gas on the coldest days by using oil and relieves the gas company from the troublesome peak, affords a higher load factor, and therefore a greater consumption per unit demand on the system. This type of equipment is illustrated in Figure 2.

Selling these ideas to the public should not prove a difficult matter because the benefits that accrue from this kind of service are usually fully appreciated and as long as the economic phase is sound there can be little difficulty in its general acceptance.

Potential Uses of Gas in Industry

The second field which offers opportunity for large volume sales lies in the use of heat for the transformation of raw materials and finished products. Here too it is a question of the price levels at which the bulk of secondary gas must be sold or if primary gas is available to what extent its value can be enhanced above competitive fuels.

Two situations exist. First, there are those heating operations where specially designed equipment is now available and where gas can be used with such overall economy that the only competition encountered is either from electricity or manufactured gas made on the premises.

In this classification there is a large field for the sales of primary load at price levels anywhere from 50 cents to $1 per 1,000 cubic feet. This applies particularly to the more refined heating operations where control is essential for proper interpretation and execution of the heating processes. This field is not limited to small equipment or operations that have low load factors but extends into applications of very large consumption with excellent load factors like those in the large steel and ceramic industries where the bulk of natural gas can be sold. The equipment used is invariably of the automatic type and usually involves a large expenditure of money as first cost which is only justified providing the source of supply is dependable not so

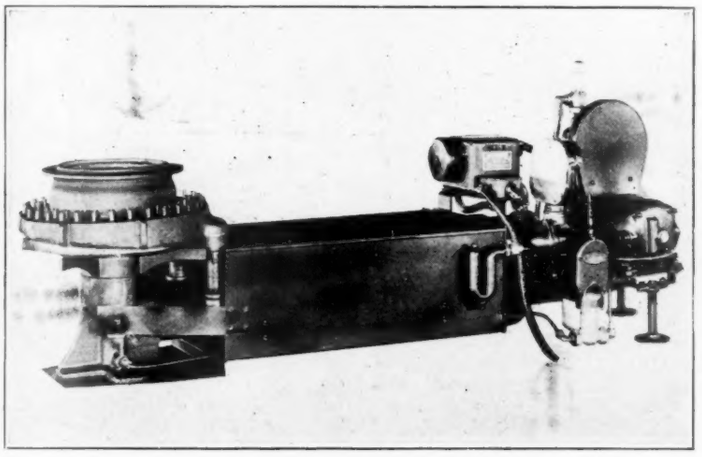


Figure 2

much because of fuel economy, but as a matter of continuous production.

Illustration No. 3 gives a good example of this type of furnace. In this installation the economies of operation produced are so far reaching that even a price of $1 per 1,000, would show low production cost in comparison with old practice, notwithstanding the fact that this furnace alone consumes in excess of 400,000 cubic feet of gas each 24 hours.

Manufacturing Problems

Unfortunately, this class of equipment has not been developed for all industries or for all the operations in any one industry. The reason for this condition is that to date there has been no recognized responsibility of either the seller of gas or the user of the fuel as to who should do the development work and to whom will accrue the greatest advantages. As a result, these developments are only more or less accidental and come more as contributions from the manufacturers of gas burning equipment than from any other source. Obviously the interest of the manufacturer is to develop equipment which either by the virtue of its patentability can be exploited by him profitably or because of the fact that its use can be generally accepted by either a great number of industries or by one of the larger industries where many units can be sold.

The experiences of the manufactured gas company have shown that this is the case and that with proper development guided by gas company interest, equipment can be developed where the value of gas is enhanced to such an extent that in many of the so-called rougher heating operations natural gas can be made to command a much higher price than is being secured for the fuel used in those operations today.

Even in the conversion of existing furnaces from other fuels to gas, proper burner equipment, design and installation determine the value of the gas used. The lack of appreciation of this factor has made it necessary for many gas companies to sell their gas at a price which is competitive with oil, producer gas or powdered coal when higher prices could have been secured by good engineering interpretation of the operation and installation of proper equipment.

The illustration shown in Figure No. 4 is a typical case. In this installation, because of increased production, lower oxidation and other losses, the cost of production with gas was sufficiently reduced so that the actual competitive value of the gas was greatly enhanced above its B.t.u. competitive value with other fuels. Better utilization equipment will not only allow for much higher rate levels in the sale of primary load for industrial purposes, but in many cases the same thought can even be applied to the sale of secondary load.

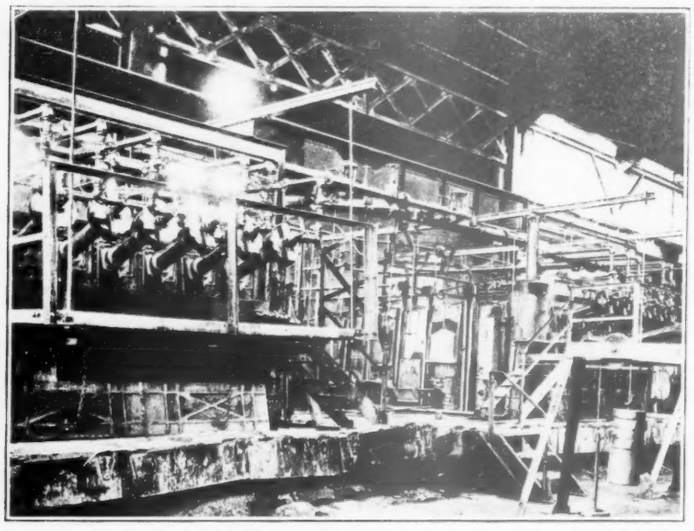


Figure 4

Another Situation

In a general way, the second broad situation that exists in the development of the industrial load applies to those industries where at the present time conditions are such that we not only cannot get a higher price for natural gas than that obtained for other fuels, but we find that in order to get the business we must actually sell gas at a lower price per B.t.u. than that paid for solid and liquid fuels.

For instance, in the cement industry, efficiency of a B.t.u. of natural gas as burned in the present existing equipment is lower than that obtained when using powdered coal or oil. There are millions, literally billions of cubic feet of natural gas used in the cement industry and while mild interest has been shown by both the users and suppliers in bringing about an improvement in the operation, no concentrated effort has been made to carry on the necessary work to improve the utilization of natural gas in this industry.

In those industries where the gas-burning equipment is a separate part of the operating equipment and represents an unusually small item of cost, as in the cement, brick, smelting and other industries, the incentive for improvement in the burner equipment by the burner manufacturers is obviously very small. Besides the field for the use of this equipment is not particularly extensive and the expense for development is often high because the experimental work to be of value must be executed on a large commercial scale. Nevertheless because of the lack of improvement in burner design the gas sold for these heating operations must be sold at a level below the B.t.u. cost of competing fuels.

If this analysis is correct, it appears that as long as the value of our commodity is measured by its performance, it surely is the duty of the gas company to see that the performance of natural gas is on as high a plane as possible. Furthermore, since the equipment used is the important factor in the results obtained, it is obvious that improvements must be made in burner and furnace equipment if higher values for our product are to be secured.

The contributions that have been made toward more efficient natural gas utilization have mostly been made by manufacturers of industrial gas equipment and while they are naturally interested in that development and have in the past made many improvements in such equipment, the economics of their operations demand that they limit their work to those heating processes that are best known to them or where the premium awarded for the solution of an industrial problem results in a material profit on the equipment they have to sell. Because of these facts a great number of heating operations which are not adapted to equipment exploitation, do not receive the attention they deserve and as a result the gas company finds itself in a position where it cannot secure a large percentage of the available business or, if it does secure the load, it must be obtained at a price which is considerably lower than it might be.

From a practical interpretation of these requirements and if the gas companies are to accept this responsibility they must create a department devoted to the solution of the industrial gas problem. Such a department should be composed of engineers qualified to analyze and solve the problems of industry and most important of all the industrial fuel department should have a supplemental arrangement with the manufacturers of industrial equipment in order to bring into the picture the necessary practical experience that will aid in solving the problems of present-day heat application in industry.

Progress is being made along this line by some of the gas companies but if better and greater markets are to be established, this phase of the business should be more generally studied and a plan adopted that will bring to the industry greater opportunities in securing the industrial load.

In summary, the enhancement of our industry is largely a matter of more detailed analysis of the important factors involved in securing the househeating and industrial loads. Our desire is to increase volume sales at higher rate levels. The basic limitation, of course, is competition.

In house heating, competitive fuels can be readily displaced by selling the homeowner a dependable and permanent house heating service with economical and efficient equipment which is fully automatic in operation.

The problem of competition in the industrial field which today greatly limits larger volume sales at higher rates must be overcome by better utilization equipment. The securing of the industrial load is largely a matter of engineering and therefore the logical plan is for the progressive natural gas company to equip itself with a well-organized industrial fuel department which will closely coordinate its activities with those organizations that devote their energies, through a large corps of engineering specialists, in the development of industrial equipment to enhance the competitive worth of gas in industry.

AN INCIDENT IN A DAY'S WORK

Constructing a 20-inch natural gas line under a railroad. Special handling is necessary when a line goes under railroad right of way, public highways, etc.

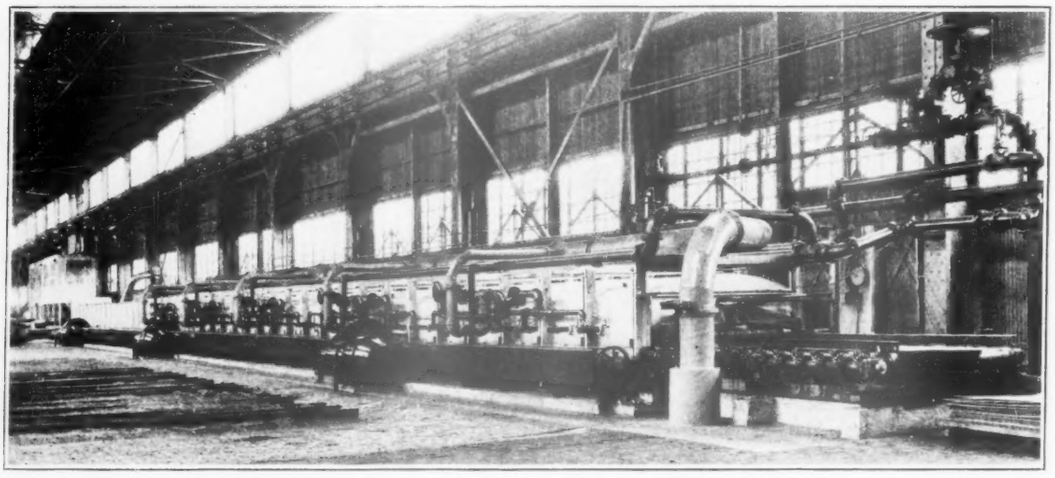
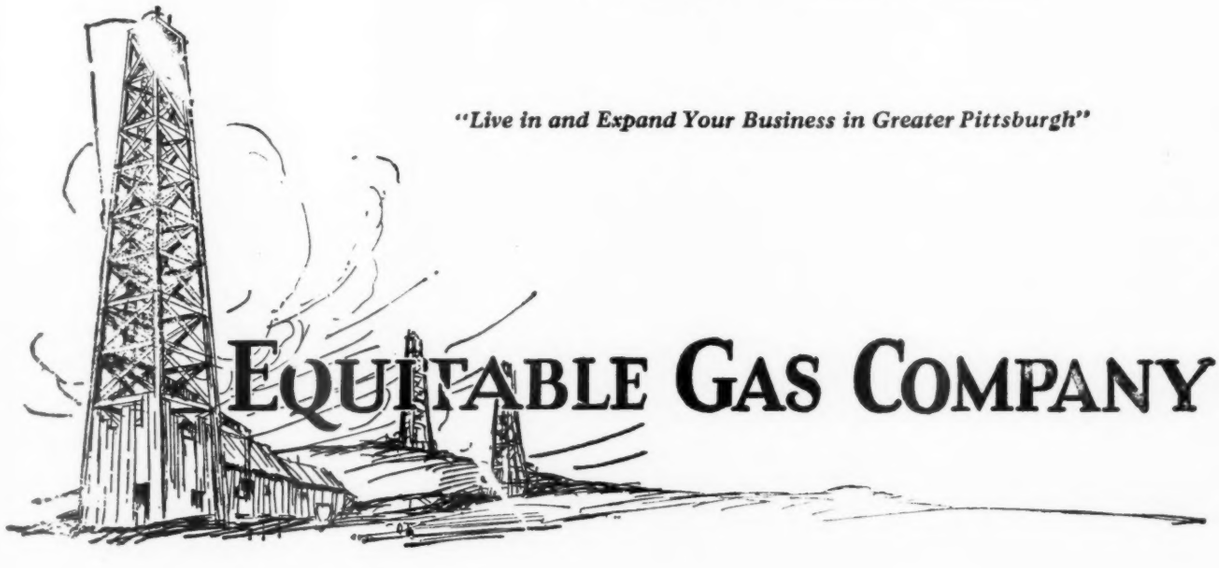


Figure 3

Guardians of Your Comfort

AWAY down along the lines into the heart of the natural gas fields, man-power toils and struggles that you may enjoy the convenience and comfort of natural gas.

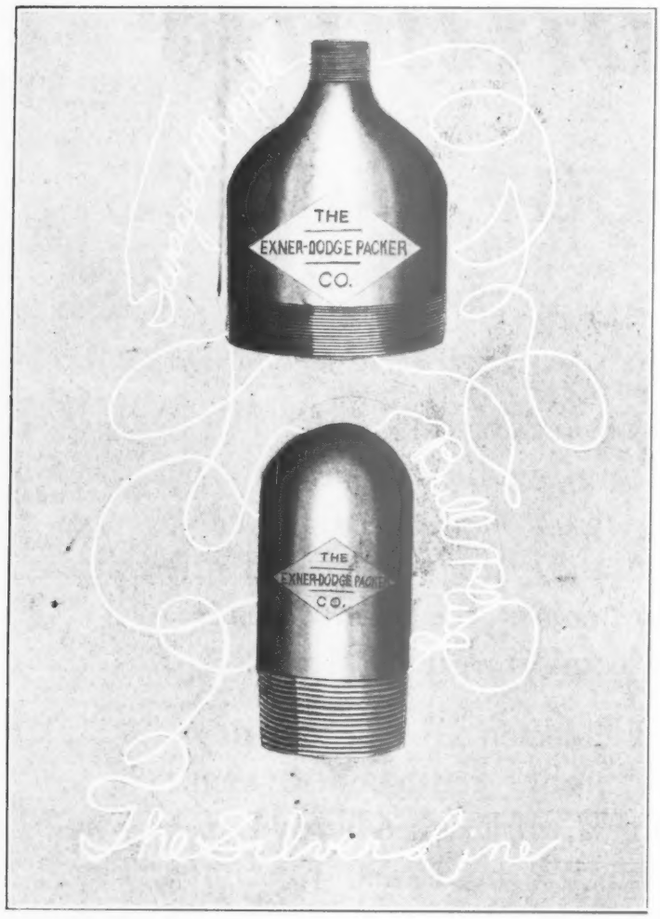
Field-men are on duty day and night—red-blooded men doing a work exceedingly hazardous, a necessary part of your Public Utility Service.



"Live in and Expand Your Business in Greater Pittsburgh"

EQUITABLE GAS COMPANY

Leaks are stopped



by the silver line

The quality that permeates the products of the SILVER LINE stops the leaks. This quality is the essence of the SILVER LINE. It is your guarantee of excellent materials, thorough workmanship and satisfying service.

No SILVER LINE swaged nipple or Bull Plug has ever been known to leak. The high grade materials, the fine details of manufacture—the elimination of burrs, the prevention of rust on threads, the machining to exact dimensions, the painstaking inspection—all guarantee satisfaction.

Ask by name for the products of the SILVER LINE.

Our swaged nipple, whose superior materials, exact machining and rigid inspection bring to you the real service of
THE SILVER LINE.

Our bull plug, whose stout nose and clean, rust-proof threads insure to you the service demanded of the products of
THE SILVER LINE

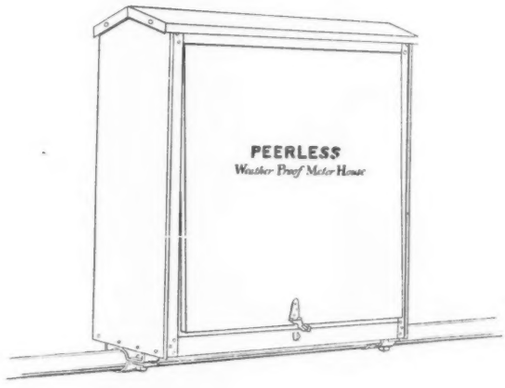
Write for our catalogue.

EXNER-DODGE PACKER COMPANY
COFFEYVILLE, KANSAS

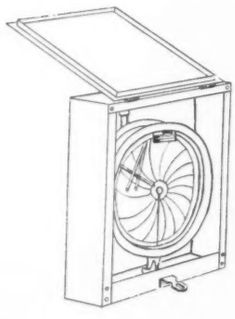
PEERLESS

Weather Proof Meter House

Inexpensive and positive protection for your meters



COMES complete including pipe, clamps and bolts, shipped knocked down and crated. Sectional—it is quickly erected anywhere. Bolted to line by means of clamps. Standard House is adapted to any size line by simply changing size of clamps. (For example meter house installed on a six inch line can be moved and erected on a three inch line by changing six inch clamps to three inch.)



Doors are hinged or removable type. Meter Houses made of 22 gauge galvanized sheet steel.

We also make the Moran Meter Cover to slip over Orifice of meter only. Neat and strongly constructed, gives positive protection.

In use by the leading Oil Companies who are standardizing upon them because of economy and durability.

Made in sizes to meet your requirements. Write for prices.

Moran Furnace & Sheet Metal Company
809 E. 5th Place Telephone 2-7902
TULSA, OKLAHOMA

Development of Measurement of Gas

Extensive Research Work Conducted by Experts has Resulted in Vast Improvement and Great Accuracy.

By John C. Diehl

For many years after the adoption of natural gas for domestic purposes, it was sold on a flat rate basis at a fixed amount for a light, burner or stove. When it was definitely determined that the natural gas supply was not inexhaustible, it became necessary to measure the gas in order to conserve nature's most valuable fuel for as long a period as possible and cause each consumer to pay an equitable amount for the fuel he used.

The domestic tin-case meter which has been developed for the manufactured gas industry was not considered suitable for use on account of the higher pressure. Furthermore, its serviceable life would have been short if installed on the outside of the house, exposed to the weather. This brought about the introduction of the iron-case meter, which usually contains the same working parts as the tin meter in an iron case.

For a long period of time after natural gas was measured for domestic purposes, it was sold in the field at a flat rate per well per year, even though the quantity might vary over wide limits. It then became necessary to develop a meter for the measurement of large volumes at high pressure in the field. This demand was filled for many years by the proportional meter which measured a definite percentage of the volume through a small meter, and by means of gearing indicated on an index the total volume passing the meter. On account of the high pressure, the application of multipliers was introduced to convert the volume actually measured by the meter into a volume which would be measured by a meter at low pressure. Later, several types of volume and pressure gauges were invented for application to proportional and iron-case displacement meters. These attachments recorded the pressure at which each volume of high pressure gas was measured.

Pitot Tube Method

In order to reduce the size of the meter and measure very large volumes, the Pitot tube method was developed and introduced by B. C. Oliphant in 1910. This method of measurement represented a definite advance in the art of measuring gas by the novel method of determining the velocity of flow through the line and computing the volume from rate and time.

About the same time a demand occurred for a recording meter which could be quickly changed and more easily handled than the Pitot tube, which simply indicated differential from which the rate was determined. To meet this need and using the same principle, the orifice meter was developed in the fall of 1911 by John G. Pew and H. C. Cooper of the Peoples Natural Gas Co. After experimental work covering six months, it was discovered that the theoretical formula developed for the Pitot tube would apply for the orifice. It then became a matter of experiment to determine the proper shape of the orifice and the method of making the connections which would give the most consistent results and least variations between high and low pressures. The tests were made at the reducing station of the Peoples Natural Gas Co. where its main line entered the city of Pittsburgh, so that the tests were conducted under actual working conditions at a point where any desired pressure up to 160 pounds could be secured and any volume up to 50,000,000 cubic feet a day was available for the tests. These tests were completed in November, 1911, and the first orifice meter for measuring gas was installed in the lines of the Hope Natural Gas Co. in West Virginia. Thomas R. Weymouth also conducted tests for the United Natural Gas Co. of Oil City, Pa. He finally decided on the same type of connections as the Peoples Natural Gas Co., but used a straight edge disc one-eighth inch thick and the downstream pressure as the static pressure, where as the Peoples Natural Gas Co. used an orifice which was beveled on the downstream side and the upstream pressure as the static pressure.

Empire Conducted Tests

About this time the Wichita Pipe Line Co., now the Empire Companies, conducted an extensive series of tests under the direction of E. O. Hickstein. In their tests they adopted the plan followed by experiments made at Charlottenburg, Germany, in 1907, and adopted the connections at 2½ diameters ahead of the orifice and 8 diameters at the outlet of the orifice.

After these companies had completed their original tests and determined the accuracy and adaptability of the orifice plate as a method for measurement of large volumes or high pressure gas, it became necessary to develop a gauge which would record the differential or drop in pressure from one side of the orifice to the other. At the time of the original experiments, no instrument was available for this purpose. It was found, however, that one of the gauge manufacturers did make a recording gauge which would record the pressure in inches of water.

"Bomb Shell" Gauge

In the fall of 1911 a gauge commonly called the "bomb shell" was developed by the Peoples Natural Gas Co. This meter consisted of a casting larger than the recording gauge, made to stand high pressure and inclose a recording gauge which would record the differential in inches of water by admitting the downstream pressure to the case and the upstream pressure to the spring of the recording gauge.

The gauge manufacturers immediately took up the work of designing a differential gauge which would give satisfactory service. During the next few years a number of types of gauges using springs and mercury chambers were placed on the market with the result that the mercury float type has been generally adopted by the orifice meter manufacturers.

Although the meters have been and are being improved to give more dependable service and greater accuracy, the United States Bureau of Standards, the gas associations, the natural gas companies, and the manufacturers have been conducting costly experiments to increase the accuracy of measurement and to formulate definite rules of procedure for testing and installation of meters, also to establish rules for the styles of meters most suitable for various installations.

The natural gas industry has been very diligent and agressive in adopting systems and methods which will promote accuracy of measurement.

All of the larger companies have a measurement department to inspect, maintain and read the meters. It is the duty of this department to be well versed in the principles of high pressure measurement or measurement under a vacuum, so as to properly interpret or prepare clauses in contracts relating to the basis of measurement.

Cubic Foot Standards

The use of natural gas and the great variation in pressure of the natural gas supply made necessary the introduction of certain standards for a cubic foot of gas. On account of the wide variation in distribution pressures and different practices originating at practically the same time, no definite standard was ever adopted, and so to this day we have several different units of measurement, each of which varies from the other on account of the variations in base pressure. The following description recites briefly a description of base pressure and the necessity for the use of multipliers for the measurement of gas by positive or displacement meters. An understanding of the principles and the bases of measurement will eliminate many of the difficulties which have been experienced by many companies in their measurement problems.

Standard Conditions

In order that the volume of gas measured at various pressures and temperatures may be expressed in standard cubic feet, each of which will contain a definite weight or heat content, the principles relating to the effect of pressure and temperature on gas must be applied.

Let us assume that a cylinder one cubic foot in volume is filled with gas at a pressure of 4 ounces above an atmospheric pressure of 14.4 pounds. The weight of the gas is definite and the cylinder contains one cubic foot at an absolute pressure of 14.65 pounds. If the pressure is increased to 14.9 pounds absolute by forcing more gas into the cubic foot of space, the cylinder will contain one cubic foot of gas at an absolute pressure of 14.9 pounds, but a greater weight than in the previous case. Let us assume that the pressure is increased by pumping some additional gas into the cubic foot of space until the pressure is 16.4 pounds absolute. The weight is further increased. In each of the above cases the cylinder contained one cubic foot of gas, and as the pressure increased the weight of the cubic foot of gas increased.

Weight and Heat Content of a Cubic Foot of Gas

Pressure above atmospheric	Atmospheric pressure pounds	Pressure pounds absolute	Weight at 60°F. pound	B.t.u. at 60°F.	Weight at 50°F. pound	B.t.u. at 50°F.
0 oz.	14.4	14.40	0.04499	983	0.04587	1,002
4 oz.	14.4	14.65	0.04567	1,000	0.04657	1,020
8 oz.	14.4	14.90	0.04645	1,017	0.04736	1,037
10 oz.	14.4	15.025	0.04684	1,026	0.04776	1,046
2 lb.	14.4	16.40	0.05113	1,119	0.05213	1,141
0 oz.	14.7	14.7	0.04583	1,003	0.04673	1,023
4 oz.	14.7	14.95	0.04661	1,020	0.04752	1,040
8 oz.	14.7	15.20	0.04739	1,038	0.04832	1,058
10 oz.	14.7	15.325	0.04778	1,046	0.04872	1,067
2 lb.	14.7	16.7	0.05207	1,140	0.05309	1,162

Again let us assume that the cylinder contains one cubic foot of gas at a pressure of 14.65 pounds absolute, at a temperature of 50 degrees Fahrenheit, and that heat is applied so that the temperature of the gas is increased to 60 degrees Fahrenhiet. Since the volume remains one cubic foot, as the temperature increases the pressure also increases. In order that the pressure at 60 degrees Fahrenheit may be reduced to the original pressure, 14.65 pounds absolute, some of the gas must be removed from the cylinder. A cubic foot of gas at 50 degrees Fahrenheit weighs, therefore, more than a cubic foot of gas at 60 degrees Fahrenheit, and a cubic foot of gas at 70 degrees Fahrenheit weighs less than a cubic foot at 60 degrees Fahrenheit, if the pressure in each instance is the same.

The value of a cubic foot of any one gas depends upon its heating value or weight which is a definite amount. Gas can be weighed, but it is not commercially practical to measure it by this method. In order that gas may be measured in cubic feet each of which will contain a definite weight for any particular gas, the absolute pressure and temperature conditions of the gas at which the cubic foot is assumed to be standard must be specified.

Definition Proposed

Some years ago the late F. H. Oliphant, at that time a member of the United States Geological Survey, considered it advisable that some standard should be adopted as a basis for the measurement of natural gas, and the following definition was proposed: "The standard cubic foot of gas is the quantity which occupies a volume of one cubic foot at a pressure of 14.65 pounds absolute at a temperature of 60 degrees Fahrenheit." An absolute pressure of 14.65 pounds is equal to the sum of 14.4 pounds, the average atmospheric pressure of the natural gas fields, and 0.25 pound, (four ounces) the average pressure existing in low-pressure distribution systems.

The proposed standard has not been generally adopted. The cubic foot at 16.4 pounds absolute, which is the reference standard in many cases, contains approximately 12 per cent more gas by weight than a cubic foot at a base pressure of 14.65 pounds absolute. In other cases gas is sold at a base pressure of 8 ounces or 14.9 pounds absolute. Eight ounces is probably the average pressure at the entrance of low-pressure natural gas systems. A cubic foot at 14.9 pounds absolute contains 1.7 per cent more gas by weight than a cubic foot at 14.65 pounds absolute.

The following table gives the relative weights of one cubic foot of gas (specific gravity 0.60) at various temperatures and pressures used as reference standard conditions, also the heat content of a cubic foot of gas at various temperature and pressure conditions, assuming that a cubic foot of this particular gas contains 1,000 B.t.u. at a pressure of 14.65 pounds absolute at 60 degrees Fahrenheit.

The terms "base pressure" and "base temperature" may be explained by the following statements: when a certain base pressure is stated, it means that a cubic foot of gas should be considered standard at the pressure mentioned. The terms "base temperature" and "storage temperature" mean that a cubic foot of gas should be considered standard at the temperature mentioned.

The above table shows that as the base pressure increases, the weight per cubic foot increases, and as the base temperature decreases, the weight per cubic foot increases. It also shows that the statement of a base pressure in "ounces above the atmospheric pressure" is not definite. For example, a cubic foot of the particular gas used for compilation of the preceding table at a base pressure of four ounces above an atmospheric pressure of 14.4 pounds contains 0.04567 pounds, whereas a cubic foot of gas at four ounces agove an atmospheric pressure of 14.7 pounds contains 0.04661 pounds. Therefore, a statement of the base pressure or the pressure at which a cubic foot is assumed to be a standard without specifying the atmospheric pressure is not definite, but a statement of the base pressure in pounds per square inch absolute is always definite.

Measurement at Low Pressure

When gas of a definite quality is distributed to domestic consumers through low pressure mains and the measurement is made at low pressure, each cubic foot of gas received by the various consumers weigh the same and has approximately the same heating value, as the small variations of pressure and temperature do not produce a material effect on the weight per cubic foot.

The following table illustrates the percentage effect on measurement for small

changes of pressure assuming that a cubic foot at 60 degrees Fahrenheit at a gauge pressure of four ounces above an atmospheric pressure of 14.4 pounds represents a standard cubic foot. The weight of gas contained in a cubic foot decreases by one-fourth per cent for each reduction in pressure of an inch of water. The effect of an increase of five degrees in the temperature is to decrease the weight per cubic foot by 1 per cent, and a decrease of five degrees in the temperature will increase the weight by 1 per cent.

Pressure inches of water at 60°F.	Pressure in ounces	Absolute pressure pounds per square inch	Per-Cent* gain or loss 60°F.	Per Cent* gain or loss 60°F.
3.00	1.7	14.51	—0.99	+0.97
4.00	2.3	14.54	—0.73	+1.23
5.00	2.9	14.58	—0.48	+1.48
6.00	3.5	14.62	—0.23	+1.73
6.93	4.0	14.65	0.00	+1.96
8.00	4.6	14.69	+0.27	+2.23
9.00	5.2	14.72	+0.52	+2.48
10.00	5.8	14.76	+0.77	+2.73

*Gain or loss from purchaser's standpoint.

Measurement at High Pressure and at Partial Vacuum

After the advent of the use of high pressure gas from natural gas wells, the problem of measurement of high-pressure gas arose. It was not practical to reduce the pressure and measure the gas at a low pressure as this procedure required excessively large meters. In many cases it would have been necessary to compress the gas again in order that it might have been transmitted to the point of consumption. This scheme was not commercially feasible. Briefly stated, the question was: how can gas be measured at high pressure and the volume be expressed as the number of cubic feet which would be measured by a meter at a pressure as low as that at which a cubic foot of gas is assumed to be standard?

Boyle's law states that if a certain weight of gas occupies a definite volume at a certain absolute pressure and if the pressure is changed, the volume must change, or, the volume multiplied by the absolute pressure is a constant, if the temperature and total weight do not change.

All displacement meters are tested to register the volume of gas in cubic feet at its pressure. If a meter registers 1,000 cubic feet at a pressure of 29.3 pounds absolute (14.9 pounds gauge pressure) and if the same amount of gas is subsequently measured by a second meter at 14.65 pounds absolute (4 ounces gauge pressure) the second meter will register 2,000 cubic feet.

The following formula expressing Boyle's law is used for converting the actual quantity of gas measured at any pressure into the quantity in cubic feet which would be registered by a meter measuring the same weight of gas at a pressure which is assumed to be the standard or base pressure for measurement:

$Q = q\,(A+p)/P_b$, in which

Q = quantity in cubic feet at standard pressure or base pressure

q = cubic feet registered by meter.

A = atmospheric pressure in pounds.

p = gauge pressure at point of measurement expressed in pounds per square inch.

P_b = standard or base pressure in pounds per square inch absolute.

Example: q = 1,000 cubic feet at 14.9 pounds gauge pressure, p; A = 14.4 pounds; P_b = 14.65 pounds absolute.

$$Q = 1{,}000\,\frac{14.9+14.4}{14.65} = 2{,}000 \text{ cubic feet.}$$

The multiplier which is used for converting meter readings into cubic feet at various base pressures is expressed, therefore, by $(A+p)/P_b$. This multiplier increases as the line pressure increases, and decreases as the base pressure increases. Assuming that the average atmospheric pressure is 14.4 pounds, the following table gives, at a glance, the relative values of the multipliers based on the above formula.

Pressure pounds gauge	Pressure pounds absolute	Base pressure ounces gauge	Base pressure pounds absolute	Multipliers
10	24.4	4	14.650	1.666
10	24.4	8	14.900	1.638
10	24.4	10	15.025	1.624
10	24.4	32	16.400	1.488
20	34.4	4	14.650	2.348
20	34.4	8	14.900	2.309
20	34.4	10	15.025	2.290
20	34.4	32	16.400	2.098

This table shows that 1,000 cubic feet at 24.4 pounds absolute equals 1,666 cubic feet at a base pressure of 14.65 pounds absolute, and 1,488 cubic feet at a base pressure of 16.400 pounds absolute.

As the base pressure increases, the equivalent quantity, corresponding to a definite volume at any gauge pressure, decreases.

The base pressure multipliers based on an atmospheric pressure of 14.4 pounds are used to convert any meter reading at various gauge pressures into cubic feet at the assumed standard or base pressure. They are derived from the following formula:

$$\text{Multiplier} = \frac{14.4+p_1}{P_b} \text{ in which}$$

14.4 = atmospheric pressure in pounds.

p = pressure at meter in pounds gauge.

P_b = base pressure in pounds absolute.

ROTARY POSITIVE DISPLACEMENT METER USED TO MEASURE GASES

By C. C. Abbott

Vice President and General Manager, The P. H. & F. M. Roots Co.

The application of the two-impeller principle to metering of fluids is one of the most outstanding recent developments in the gas industry. The increasing demand for greater savings of time and material elements in all industrial and commercial efforts makes accuracy an issue of paramount importance. Any development which provides a better solution for this basic principle holds much interest for those who are responsible for improving plant operating conditions.

The basic principle involved in the design of the positive displacement meter was originated by the Roots brothers in 1859. The exact date of the first meter of this type is not available, but drawings and records have been located which show that the principle was applied to metering as early as 1868. These meters were equipped with revolution counters and a means of turning the rotors by hand for the purpose of inspecting and testing.

The positive displacement feature is really the fundamental characteristic upon which this type is established and units of this construction can deliver a definite, pre-determined volume of fluid. This principle permits gas operators to use their positive displacement exhausters for metering when their station meters have been cut out of service for repairs.

The early efforts to use this principle for metering exclusively did not meet with active support, because accurate determinations were not considered of great importance at that time. The increasing demand for accuracy has made it possible for this type of unit to receive attention. Improvements in machine shop practice and especially the introduction of reliable antifriction bearings of the ball and roller type, have combined in the production of a unit of this type which will satisfactorily meet a wide range of requirements.

Application of the rotary positive displacement meter can be made for measuring fluids for any practical range of volumes, but the most extensive use has been made for measuring gases. This type is extremely flexible in regard to both volume and pressure. Line pressures up to fifteen pounds are permissible with units of standard construction. Without material change other than strengthening of the case, this type may be built for pressures up to 80 or 100 pounds. These units found favor as station meters for manufactured gas, but are equally suitable for blast furnace, coke oven and natural gas for either low or high pressure distribution.

In some localities it is advantageous to mix different proportions of different gases, such as natural and manufactured. Such requirements are conveniently met by employing two meters of this type connected by suitable coupling when the displacement ratio of two standard units represents the desired ratio, or by gear train when other ratios are required. If conditions necessitate several ratios, change gears can be provided to operate on a fixed center distance. In this construction, stuffing boxes are eliminated with consequent elimination of friction loss by placing the connecting mechanism in a gas tight housing having an easily removable cover to facilitate the changes. This arrangement is illustrated in Figure 1.

Principle of Operation

The principle of operation is essentially the same as the operation of the rotary

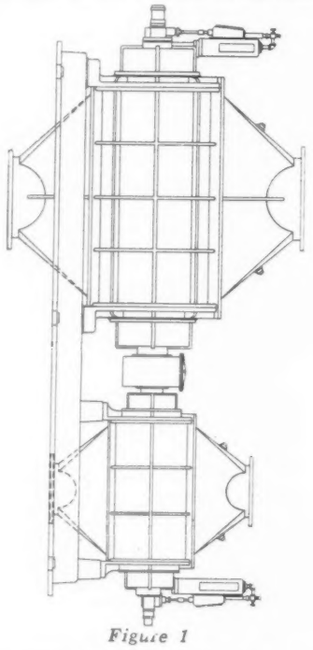


Figure 1

gas pump. Two light-section cast iron rotors are mounted on parallel shafts rotating in opposite directions. The shafts are journaled in bearings and connected by means of gears at each end of the meter. Gas enters at the top, moves the rotors around and fills the space between the rotors and the case. The lobe tip cuts off the opening to the inlet side when the space is filled. The opposite tip at the same time opens to the discharge side and the rolling together of the rotors in the center prevents the return of the gas to the inlet side. This displacement takes place twice for each revolution of the rotors, or four times for a complete cycle of the meter. It is therefore only necessary to obtain a count of the revolutions to obtain an accurate record of the volume or gas passed by the meter. These meters are designed for inlet at the top with discharge at the bottom, because for bottom discharge the rotors operate in a direction which permits any entrained impurities to be carried through the meter without serious interference. The only attention required consists of proper lubrication of the bearings and gears. A by-pass for the meter should be provided so that it can be disconnected from the direct service line for inspection, checking and testing. The design and construction of this type represents extreme simplicity.

Readings and Instruments

To obtain a reading from this type of meter, the only instrument is a revolution counter which gives the integrated number of revolutions made by one rotor shaft. In order to provide the most convenient reading, it is desirable to have the revolution counter driven through a train of gears which eliminates the necessity of multiplying the total revolutions by the displacement per revolution. When so designed this instrument then becomes a volume integrator reading direct in cubic feet. It is customary to include in this volume integrator drive the very small correction for the differential across the meter. A decided advantage is obtained by designing the train of gears so that various ratios may be applied to meet various operating conditions. This method results in a refinement which gives an exceedingly high degree of accuracy over a wide range of flow rates. The correction should always be based on the meter test, taking into consideration the range of flow rates as specified by the user. If operating conditions change at any time after the meter is installed, the gear train may be changed to give the proper correction for the new conditions. While additional refinements to this reading can be made based on different flow rates, these corrections are so small that they are generally disregarded, in which case the direct reading from the integrator is used without any further correction.

As a rule, each meter is provided with a differential gauge reading in inches of water column. The inclined tube gauge of simple construction gives very accurate readings. The fluid column on this gauge is readily adjusted and the pipe lines leading from the gauge to the inlet and outlet of the meter are fitted with valves so that the gauge can be checked at any time. In service the gauge is used only as a general check on the operating conditions of the meter.

On account of the almost complete elimination of friction and inertia meters of this type can be operated at maximum capacities on a differential pressure of less than one inch water gauge. The differential required increases with the speed of the meter, which in turn is governed directly by the flow rate. For peak loads of short duration, speeds can be increased very materially with no detrimental effects.

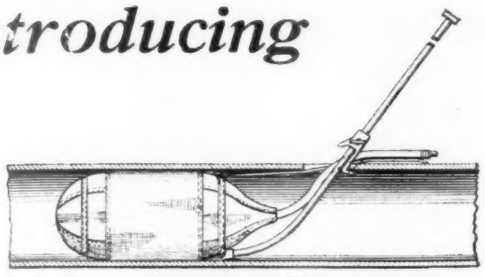
The rotary positive displacement meter measures fluids under conditions as passed and the only correction necessary to the reading taken from the volume integrator is the correction for temperature and pressure. If instruments are not already available for obtaining these readings, gauges can be applied and mounted directly on the meter properly connected to give accurate record of the gas temperature and pressure. Standard multipen gauges are now available and represent the most convenient form of obtaining temperature and pressure records on a single chart.

Additional instruments for particular operating conditions have been successfully applied. The distant volume integrator is sometimes desirable. This unit is operated by magnetic contactor on the meter and duplicates at a distant point the readings of the volume integrator on the meter. This distant volume integrator is usually located in the plant office, or on the operating floor at the water gas set.

The printometer gives a printed record of the integrated volume passing the meter and can be located at a distant point from the meter. Readings of this instrument can be made to follow the flow rate over various time intervals ranging from one reading every ten minutes to one reading every 60 minutes.

The flow rate indicator and recorder is operated directly from the meter and may be located at any convenient distant point.

Introducing



Patents Pending

The Goodman Cylindrical Stopper

(High Pressure)

An inflatable bag with a fine, strong waterproofed casing for use in gas, oil, water and drain pipes. So designed and made that it may be inflated to a high pressure, anchored in place so that it will not creep in the pipe or become displaced, and forming a perfect seal against gas or liquid. Easily inserted and withdrawn.

SENT ON TRIAL

Safety Gas Main Stopper Co.

523 Atlantic Avenue, Brooklyn, N. Y.

Pacific Coast Representative:
C. B. Babcock Co.,
San Francisco, Cal.

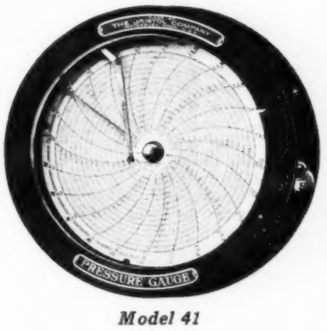
New England Representative:
Eastern Service Co.,
Boston, Mass.

Guarding natural gas profits

From well to consumer, at every strategic point, there is a BRISTOL'S RECORDING INSTRUMENT designed especially to supply the information essential to profitable operation of natural gas companies.

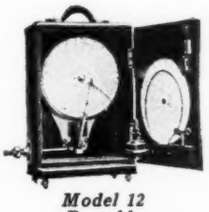
Model 11

RECORDING PRESSURE GAUGE, Original Form, Model 11 can be easily installed at any point where a record of pressure is desired. The continuous record shows exactly how pressures are running at the well; also detecting the possible presence of water. On high pressure lines it immediately gives evidence of leaks or sudden breaks. On intermediate lines the chart shows not only the performance of the regulator, but also how pressure holds up in relation to gas consumption. For low pressure lines the Gauge provides a continuous record of pressure maintained, and will give information of leaks.



Model 41

RECORDING PRESSURE GAUGE, Round Form, Model 41—Used for every purpose where a Model 11 is suitable. This round form with the inverted penarm is sometimes preferred. The case is moisture-proof.



Model 12 Portable

RECORDING PRESSURE GAUGE, Portable Model 12—Light and easy to carry about, to install at customer's premises for checking complaints of low pressure. It is also used for running leak tests, locating water in the line, and to check regulators when testing, or when set for special loads.

ATMOSPHERIC RECORDING THERMOMETER, Model 311—Provides a continuous chart record of outdoor weather conditions, thus giving advance warning of coming consumer demand, due to possible changes in temperature. This permits the setting of regulators to meet any anticipated change in load. Because they outline the complete range of daily temperatures such records are often useful in satisfying consumer complaints as to the amount of gas used.

Write for complete information.

Model 311

The Bristol Company Waterbury, Connecticut

FOR 38 YEARS — Ask Any Technical Engineer — MAKERS OF

BRISTOL'S RECORDING INSTRUMENTS

Compression Process Gaining Favor

Development of Gas Lift in Oil Fields Turns Attention of Operators Again to Benefits of Using This Method

By Emby Kaye
General Superintendent, Natural Gasoline Production, Skelly Oil Co.

The general awakening of the industry to the understanding that the oil absorption process could effectively be employed to treat rich casinghead gas issuing from oil wells gradually brought about a state of mind within the industry that the compression process was obsolete. Practically 95 per cent of the plants constructed after 1921 were of the oil absorption type, while an exceedingly great number of compression plants were converted to utilize the absorption process. At the present time the situation is precisely the reverse of what it was only five years ago, when the records showed that fully three-fourths of the natural gasoline was manufactured by the compression process. Today considerably less than one-fourth of the production comes from this source.

We may briefly study the theory upon which the compression process is based to see why this simple process lost favor and why it was superseded by the more complicated and more technical absorption process.

Disregarding a number of extraneous and sometimes bothersome gases, natural and casinghead gases are composed of hydrocarbons in which those of the paraffin series predominate. Methane, ethane, propane, butane, hexane, and heptane are present in varying proportions. Of these, the first four are gases at ordinary temperatures, while the last three are liquids. Natural gasoline may contain the last four, as, under certain conditions, butane is not an undesirable constituent of motor fuel. The extent to which these gasoline vapors appear in a gas is almost wholly dependent upon the character of the oil in the sand, the pressure and temperature existing in or maintained upon the sand, the porosity of the sand, and the manner in which the oil and gas is produced, that is to say, the extent to which they are brought in contact from the bottom of the well to the point where the gas is taken to the gasoline plant for processing.

Theory of Compression

There are a few simple physical principles upon which the theory of the compression process for the recovery of gasoline from natural gas is based. The pentanes, hexanes and heptanes are the chief constituents of crude oil, which have such vapor pressures as cause them to be distilled from the crude oil at earth temperature. These will be, with propane and butane, which may or may not come from the oil, the more important of the constituents of natural gasolines. Vaporization is a tendency of the molecules of a liquid mixture to leave the liquid. "The force of their impact on any surface that may be interposed is the pressure known as the vapor-pressure of the liquid at any particular temperature." In a confined chamber "the number of molecules leaving the liquid for the vapor, or returning to the liquid, will be equal if a small time interval is allowed for the system to reach the condition of 'equilibrium'." Every substance has its own vapor pressure at a given temperature. Several hydrocarbons, in a mixture, each exert a pressure. If the total pressure is doubled, by compressing the gas into one-half of its original volume, the partial pressure of each component is also doubled, and follows Boyle's Law. Now then, Dalton's Law of partial pressures states that the total pressure of a gaseous mixture is equal to the sum of the partial pressures of the component gases. Hence, an external pressure in excess of the vapor pressures will liquefy these gases. Excessive external pressures required may be reduced by cooling the gases because the vapor pressure of a liquid increases with temperature.

In actual plant practice we find that in addition to liquefying these gases by the application of pressure and lower temperatures, some butane is absorbed by the liquefied heavier constituents, and that some propane is dissolved.

External Pressures

The external pressures necessary for the condensation of natural gasoline depend upon partial pressures of the gases and vapors present in the mixture, but which are difficult to determine. Other actions take place along with condensation (referred to in the previous paragraph), absorption and solution of some gases that would not be compressed to a liquid except at lower temperatures. Hence, the early plants of Richards and Gray, although higher pressures were tried, 250 pounds in the first and 90 pounds in the latter, were found satisfactory. Richards went as high as 400 pounds but found in this pressure no particular advantage. The industry came to design plants to operate to 250-pound pressure, but equipment was used which would permit raising the pressure to 300 pounds or dropping it to 200 pounds, according to the results achieved. Obviously, where large quantities of propane, butane, or air were present, higher pressures would be necessary, whereas the pentanes, heptanes, and hexanes, with negligible quantities of the former gases, would be "knocked out" in actual practice at pressures as low as 90 pounds.

As the industry developed, a considerable number of plants were built which employed various forms of refrigeration to cool the gases. In some cases ammonia was used, and in others "expanders." However, it is doubtful whether the latter were even justified as not sufficient refrigeration was obtained by compressing the dry gases and expanding them to increase the recovery of natural gasoline. Essentially, however, nothing of a novel character appeared in the design of a compression plant from the first commercial plant in 1905 until the end of 1920 when the production had climbed in excess of 1,500,000 gallons a day. It was then the absorption process began to supersede the compression plant.

Absorption Wins Favor

There are many reasons why the absorption process won favor. In the first place it was adapted to any character of gas, extracting all but a trace of the contained gasoline vapors, while the compression type was efficient only on rich wet gas. Writers have stated that the process should not be employed on gas leaner than 1 gallon per 1,000 cubic feet of gas. In actual operation, however, it has been proven many times that gas should be at least 2 gallons before it can be extracted with relative efficiency. Theoretical tests do not take into consideration the imperfect cooling which is experienced in plant practice, or the air which gradually finds its way into the gas system and which lowers the partial pressures on the gases, hence reducing their effective condensation.

In the case of gallon and a half gas (most plants built in the past five years have been on flush gas and one to one and a half G. P. M.), the cost of a compression and an absorption plant are about the same, and for leaner gas the latter is considerably cheaper.

In the absorption process, the absorbing medium absorbs the heaviest hydrocarbons first, and thereafter those higher up in the series. It was thought that by limiting the oil circulating, the stable gasoline fractions could be "selectively" absorbed from the gas. What fixed gases were entrained in the oil could be expelled by lowering the pressure up to the point required on the vent tank. The final product would then be less volatile and meet the requirements of an embattled refinery trade which was more or less fed up with wild casinghead gasoline and with kerosene blends. (During the years 1922 and 1923, this was found to be an inefficient way to produce a less volatile and merchantable gasoline). For a time, only absorption gasoline was desired, regardless of specifications.

Pressure Hazard

A further reason for the loss of favor of the compression process was the elimination of the hazard due to high pressure. The risks inherent in a row of compressors pumping gas, and often mixtures of air and gas, up to 300 pounds, are obvious. Cooling coils carrying gas and gasoline vapors at such pressures present a greater danger, particularly after the plant and coils have become partly corroded. In the oil plant the pressure is seldom higher than 35 pounds and involves no particular hazard. There are half the number of engines to maintain, and, where the water is not the best, this is an important factor.

The past five years have seen the development of various kinds of fractionating processes for stabilizing natural gasoline. The product of the compression plant yields as easily to processing by this equipment as that of the absorption plant. Gas with an initial gasoline content of 1½ gallons may well be treated by the compression process, particularly if the gas comes from a field where vacuum will be applied and where richer gas may be anticipated. From an economic standpoint this is justified because the compression plant decreases in cost in proportion to the oil plant as the gas becomes richer. The cost and number of compressors depend solely upon the volume of gas to be compressed, while absorption equipment, aside from the low stage compressors, increases in an almost direct ratio with the gasoline production. This statement is made advisedly from practical operations and runs counter to the theories of two of the ablest engineers in the industry. (Reference is made to the theory that oil circulation may be calculated upon the basis of gallons per 1,000 cubic feet of gas. This does not work out with year-around conditions when temperatures rise and when the volume of oil circulated must be increased unless the cooling equipment is built entirely out of proportion. Increasing the oil circulation of course involves increasing all of the absorption-distillation equipment.)

Use With Gas-Lift

There are, of course, sufficient offsets to the saving in first cost that would encourage manufacturers to use the absorption process, but such justification would cease when the gas upon testing is found to yield 4 or 5 gallons. But there are instances where in recent years compression plants were installed on 1½-gallon gas because of special circumstances, and these circumstances are bound to figure in the types of plants selected in the future. In these cases, high residue gas was necessary. The obvious thing to do was to build compression plants.

Thus is is that large compression plants were built this year when the process was considered obsolete. Such plants will continue to be built in conjunction with gas-lift stations, gas-reinjection plants, and gas-booster stations. In all these enterprises, pressures upwards of 250 pounds are generally required, and what more simple than to throw in intercoolers and fractionating towers, a few storage tanks and a boiler, and save the natural gasoline. The life of a gas-lift station is too uncertain to justify complicated absorption equipment, more certainly so if the gas contains a higher than 1 G. P. M. When the gas-lift service is discontinued, it is most likely that the gas and oil volumes on the property are so very much diminished that it would be most economical to continue as a high compression plant, but, in any event, if absorption is then indicated, half the compressor units may be taken out and absorption equipment installed.

This arrangement is receiving consideration not only by producers who operate their own gasoline recovery plants, but by others also. The gasoline plant sells pressure for gas-lift to the producer who disposes of his gas to the gasoline manufacture, and it appears that this sort of exchange and co-operation will be the order of the day. The producer will have his gas-lift, but he will not have a lot of compression equipment on his hands every time he develops a property. A fair equitable price on the part of the gasoline manufacturer will result in large economically-operated gas-lift stations, with a minimum of down-time equipment held for emergency. This is a form of unit operation that does not involve the almost insurmountable obstacles presented by unit control in the production of oil.

Same With Gas Drive

Precisely, the same idea may be carried out with respect to the gas drive, where this method of oil recovery is practiced, one plant returning gas at a predetermined pressure to the leases in the unit. There are a number of fields where the surplus gas is being reinjected almost from inception of the field. Where this procedure is indicated, why should consideration not be given to install a compression plant that will serve both the gasoline manufacturers and the producers?

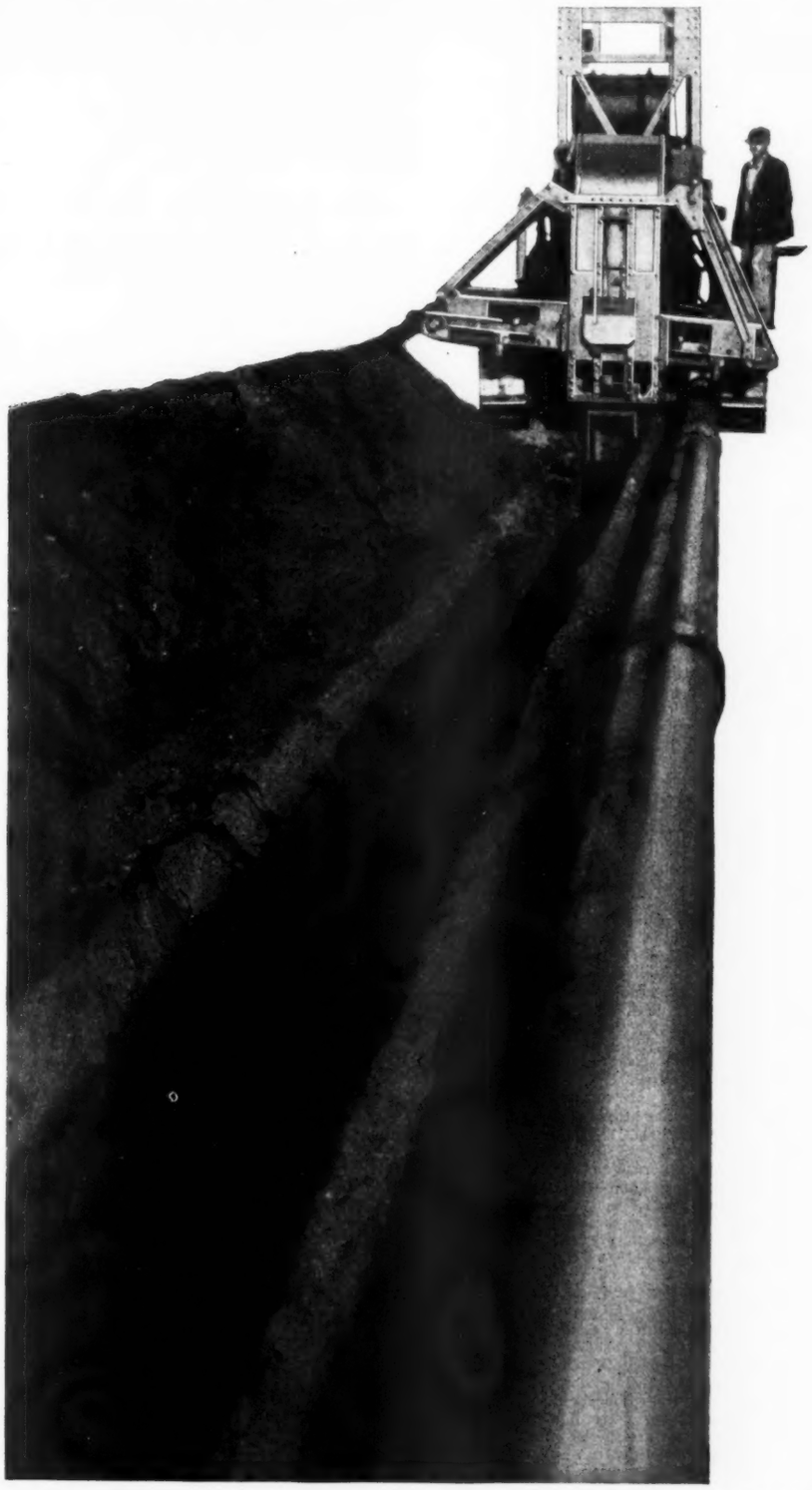
The third situation justifying compression plants on gas containing upwards of 1½ gallons of gasoline per 1,000 feet of gas, is that wherein there is a definite opportunity to dispose of all or a great portion of the surplus residue gas. There are small installations where this might not be justified, but, as a general rule, where the life of the field is expected to be long extended and where the sand formation is known to produce considerable quantities of gas along with the oil, compression would still be justified, at least as long as great volumes of gas could be boosted and sold. If the gas does not increase in richness after several years, the process may then profitably be changed when the income from dry gas sales has about disappeared, but if the content has increased to 3 or 4 gallons, the compression process, as already indicated, will be as desirable as any other and as efficient from the standpoint of net profits.

It is undoubtedly true that the so-called stabilizer had much to do with the rejuvenation of the compression process, as already indicated, will be as desirable as any other and as efficient from the standpoint of net profits.

It is undoubtedly true that the so-called stabilizer had much to do with the rejuvenation of the compression process. By its use, product control has been achieved, as already remarked, also with compression gasoline.

At first, stability was accomplished by steaming the wild compression product, or by lowering the operating pressure of the high-stage machine. The latter, in cutting down the amount of wild fractions, such as butane and propane, by lowering the partial pressure inadvertently cuts down the yield of the heavier ends. On the other hand, steaming the

ONLY THE BARBER-GREENE HAS THE VERTICAL DIGGING BOOM AND THE OVERLOAD RELEASE



Riding the Pipe Lines to Lower Ditching Costs

Out in the oil and gas fields Barber-Greene Ditchers are riding the pipe lines to new records up to 6200 feet of trench per day.

In cities and towns they are digging gas and water mains through mazes of underground pipes. They are digging service laterals and stubs — jobs that no other ditcher could successfully handle before — with more care and precision than hand labor.

Everywhere Barber-Greenes are showing unequalled low costs of from 4 to 8 cents per lineal foot.

And directly responsible for this phenomenal performance is the Vertical Boom that digs straight down with its famous "milling action"— the Overload Release that prevents damage either to the machine or the obstruction it encounters—and the full length crawlers that march straight down the line.

Partial List of Users

Standard Pipe Line Co.
Pacific Oil Company
Louisville Gas and Electric Co.
Lone Star Gas Company
Houston Gas and Fuel Co.
Houston Nat. Gas Co.
Arkansas Nat. Gas Co.
Arkansas Water Co.
Justin Matthes Co.
Gulf Pipe Line Co.
Upham Gas Co.
Dallas Gas Co.
Producers and Refiners Corp.
Phoenix Utility Co.
Cocke and Turner
Sinclair Texas Pipe Line Co.
Southwestern Gas & Electric Co.
Prairie Oil & Gas Co.
J. C. Connor & Sons
Union Oil Co.

BARBER-GREENE COMPANY, 600 WEST PARK AVENUE, AURORA, ILLINOIS

Barber-Greene

Barber-Greene Ditcher

Representatives in 50 Cities

DISC FEED LOADERS VERTICAL BOOM DITCHERS
STANDARDIZED PORTABLE AND PERMANENT BELT CONVEYORS
SNOW LOADERS CAR UNLOADERS COAL LOADERS

compression gasoline was a wasteful business because in eliminating the propane gas, a considerable amount of heavier ends was carried off. Thus, fractionation, a "method" in use in refineries for cutting products to particular specifications, was finally applied to natural gasoline manufacturing. Many types of refluxers are on the market and available, and many concerns have developed designs of their own and have put to work ideas with reference to fractional condensation and distillation which are age-old and which have been used in solvent recovery plants in the separation of gases of varying boiling points. The impelling aim is to eliminate as much of the propane as possible from the raw gasoline so that the finished natural gasoline shall have in it the hydrocarbons from butane down, and only that amount of butane desired to be retained, as will be dictated by market conditions and the current demand as to the recovery desired.

Stabilizing Gasoline

In order to understand the necessity of stabilizing natural gasoline, the following table of boiling points of the various constituents of natural gasoline is set down so that they may be observed:

Methane	—256.0
Ethane	—119.4
Propane	—47.4
Butane	32.5
Pentane	97.7
Hexane	156.2
Octane	257.9
Nonane	302.9

It is practically impossible to retain any methane or ethane in the finished product because of the exceedingly low boiling points. It is, however, almost impossible to manufacture natural gasoline by any of the known methods without absorbing a considerable quantity of propane in the heavier ends and in the lower fractions of natural gasoline. It is highly desirable to expel all of the propane from the finished product because the propane will eventually evaporate from the body of natural gasoline and in so doing will carry off appreciable quantities of desirable merchantable gasoline.

A rectifying tower has been employed in the last few years for the purpose of rectifying the compressed gasoline without retaining in the product any propane, and, as has already been indicated, only that amount of butane desired, according to the market conditions and the current demand for the various grades of natural gasoline. This tower is known as the stabilizer and permits by a very fine control of temperatures within the tower, of condensing only the gases within the temperature ranges desired.

Almost any degree of temperature down to 25 below can be attained by the more efficient installations, but temperature alone is not sufficient. It is essential to satisfactory operation that the temperature range be gradual within the tower so that the product may be controlled at will. The low temperatures are achieved by the expansion of the high compression gasoline which is mostly propane and butane.

The propane and that portion of the butane eliminated through the stabilizing process are carried off to the residue system or burned as waste gas. However, the increasing amount of such gas, as a result of the increased demand for more stable products, has led engineers to try to develop a market for these liquefied gases. Several markets are in the offing.

Plant Operation

The operation in compression or absorption plants is not dissimilar essentially. In the compression plant all the gasoline is fed into the tower. The lowest make is fed in at the lowest point, the recompression at the top, and the so-called low gasoline between these two points. In all events, the making pressure is maintained by regulators until just before the gasoline enters the tower where it is expanded by the pressure drop. At the top of the tower, it is attempted to maintain as nearly atmospheric pressure as possible.

The reflux in the bottom of the tower goes by gravity into an accumulator tank. In this tank, or kettle, the product is steamed by means of enclosed steam coils and that temperature maintained as will give the desired distillation recovery to the product. The vapors steamed off enter the stabilizing tower just above the liquid level in the tower and are cooled as they rise by the gradually decreasing temperatures, whereby some of the vapors are recondensed and trapped back to the kettle or accumulator.

The temperature at the top of the tower is the key to the control of the product. This temperature is affected, first, by the amount of high compression liquid that is fed into the tower, and, second, by the expansion within the tower, which latter is in turn controlled by the pressure drop within the tower chamber. It is desired that only enough of the high volatile fractions (composed mostly of propane) be fed into the tower to bring about the desired temperature for fractionating the vapors coming from the kettle. In order to bring this about, only enough gas is taken from the top of the tower for recompression as will serve this purpose, while the rest is turned into the fuel system or burned. In some cases, where the recompression machinery is not loaded, all of the gas is recompressed and all of the high pressure condensate returned to the tower. If this is done, the only gas (propane and some butane) withdrawn from the system is released at the high pressure accumulator tank. If this exit was not provided, the result would be that more and more propane would be kept within the system, with the result that the service of the fractionating tower would be nullified and the product within the kettle or accumulator tank would always be of high vapor tension, high gravity, and low recovery. It is essential that some means be provided for withdrawing from the system part of the vapors sifted through the stabilizing tower and only enough circulated, as previously stated, to provide ample refrigerant.

Use of Stabilizer

It is erroneous to say that a stabilizer increases the plant production, per se. Unless the plant happens to be oversized and vapors driven off can be rehandled over and over again, the stabilizer makes possible the increase in volume of gasoline sold and otherwise adds economies. Indirectly, the stabilizer should make possible the following:

1. Separation of fixed gases from salable gasoline.
2. Control of the product.
3. Economy of steam as against steaming for product control.
4. Liquefaction of propane-butane for sales purposes.

Given the proper stabilizer it is important that the operating conditions be religiously observed. The machine should be automatic as far as possible, but like all automatic equipment must be checked often. Once the temperature which achieves the most efficient separation is ascertained, the controller on the "high gasoline" feed is set so that the desired temperature may be obtained. The steaming of the kettle or in the base of the tower should also be automatic. While it is possible to control the temperature by the gravity of the liquid, this refinement has not yet been installed in connection with a stabilizer. Instead, a series of distillations are run until a given temperature of the liquid yields a product of the desired "recovery."

In some new plants where the gas is high in gasoline content, it is proposed to treat all raw gas through fractionating towers in order to increase the efficiency of extraction. This, together with the other uses to which the compression process can, and is being put, makes one feel that it is undoubtedly too early to hold obsequies for this process.

USE AND CARE OF PROPORTIONAL AND DIRECT READING GAS METERS

By T. C. Clifford

The proportional meter consists of a housing having inlet and outlet connections and a partition in which are located a plurality of proportional valves dividing the incoming volume into two streams, one large and one small, and locating a meter in the smaller stream so that the total volume passed can be determined.

The function of the valve mechanism, which is automatically operated by the flow, is to maintain a constant ratio between the two volumes so that the measurement of the smaller volume may be used as a basis for arriving at a knowledge of the entire volume passed.

The principle of construction of the proportional meter is based upon the well known law that the quantity of fluid which passes through an orifice at a given pressure is in direct proportion to the area of that orifice, and changes in direct ratio to any variation in the sizes of such orifice.

The operation is as follows: The gas entering the inlet of the housing encounters the main valve located in the partition which diverts a flow of gas through a by-pass in which is located a meter and the small valve which is actuated by the movement of the main valve. As the main valve opens and closes in response to the variations in the flow of gas the small valve is operated in constant ratio so that the quantity of gas passed through the small valve and meter bears the same relation to that passed through the main valve, and the register of this meter is so geared and the dial so marked as to indicate the total volume passed through both valves although only a small proportion of the gas has been actually measured, hence the name proportional meter.

Use of These Meters

For operation under high and varying pressures, a volumetric recording attachment is used whereby a parallel reading of the volume measured and the pressure at which it is measured is obtained, thus permitting of the application of the proper coefficients or multipliers to correctly expand the meter readings to their equivalent in low pressure gas at any desired base.

Proportional gas meters are used principally for field and industrial service in the measurement of large volumes of natural gas under varying pressures where the number and size of positive meters and the expense involved in their installation would be prohibitive.

Meters of this type require sufficient attention to keep the valve mechanism clean and free from deposits of foreign matter as any interruption to the free movement of the valves or change in the size of the valve openings would tend to destroy the balance of the meter and affect its accuracy.

The method of checking and correcting these meters in the shop is by connecting them to a large prover and comparing the reading of the tally meter register with that of the prover. In the field, a flow meter may be used and the meter readings compared with the results secured by computing the flow through different sized orifices in the prover by means of a stop watch, barometer and pressure gauge, which operation is familiar to all gas field service men.

Direct reading gas meters are those through which the total volume passed is measured and registered in cubic feet or other units of volume, and may be divided into two well-known groups: Wet, or liquid seal, gas meters and dry gas meters, the latter being made with tin or cast iron outer cases.

The liquid seal gas meter is made with a cast iron upper and lower shell with inlet at bottom and outlet at top. The measuring drum in this meter consists of two spherically-formed pans divided by six partitions and secured to the valve seat and mounted on a universal joint in the lower shell and held in angular position in the upper shell by means of a link, permitting the measuring drum to nutate around the center, causing the valve in the valve seat to direct the inflowing gas to the six measuring chambers which fill and discharge at each revolution. To the upper end of the link is attached a suitable movement shaft to transmit the motion to the register where the total volume is indicated. Oil or some similar nonvolatile liquid is used as a seal in meters of this type in lieu of diaphragms, the lower edges of the drum dipping into this liquid thus forming the measuring compartments.

Dry gas meters consist of a tin or iron case in which are mounted a plurality of measuring compartments surrounded by diaphragms or bellows made of lamb skin or other suitable material and controlled by automatic valves so that they are alternately filled and emptied by the gas passing through the meter. The valve mechanism is connected by a system of gearing with the register upon which the amount of gas measured is recorded.

Tin meters for the measurement of manufactured gas have been in use since early in the nineteenth century, but the advent of natural gas late in the same century made necessary the substitution of cast iron for the outer cases on account of the higher pressures at which the gas was handled.

Tin and Iron Meters

Tin meters have always been constructed with four measuring compartments, two inside and two outside the accordian-shaped bellows or diaphragms, which compartments are connected by suitable passages with two D slide valves located in the top of the meter case, which are in turn operated by so-called flag wires connected to the diaphragm heads.

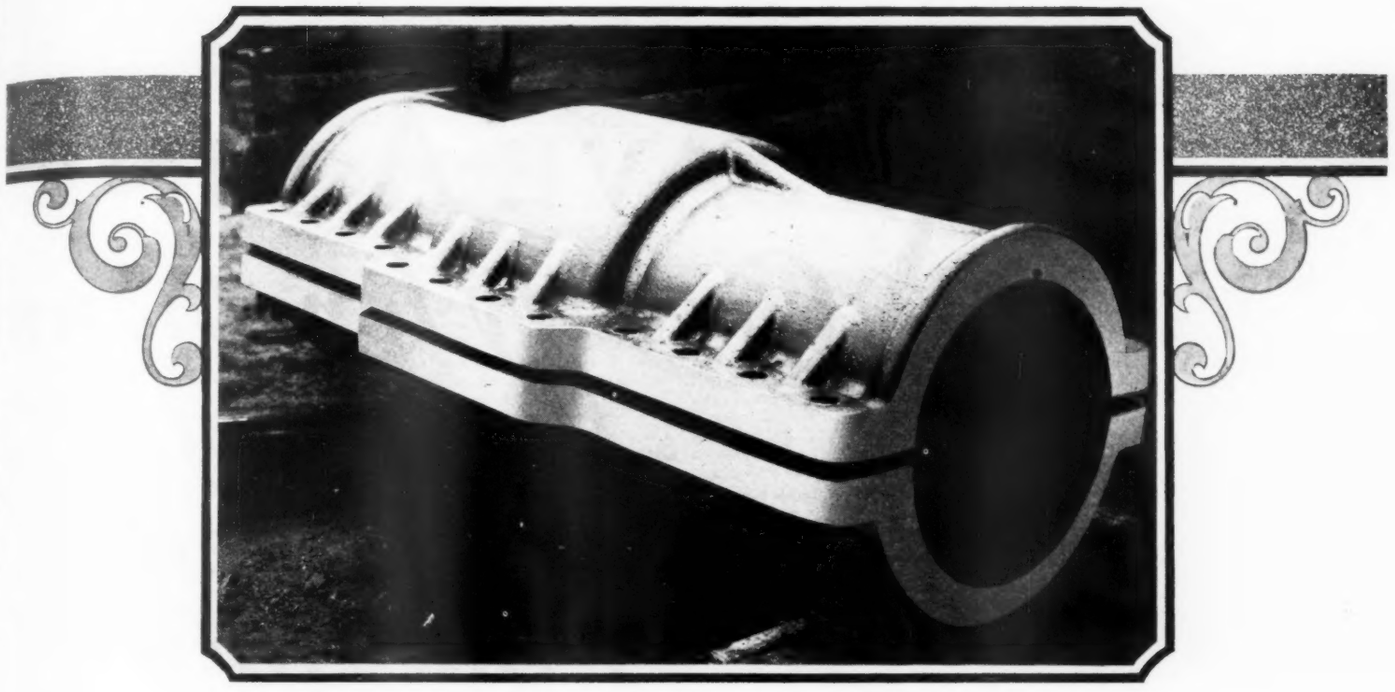
Early models of the iron meters differed from this construction materially, in some instances as many as five diaphragms being used and rotary valves being substituted for the slide valves. Later developments in the iron case meters, however, have followed more closely the tin meter design and the majority of iron meters now on the market embody the tin meter principles in their construction with the added advantage of greater strength and rigidity in the outer cases, together with ease of access for cleaning or repairing.

Direct reading meters are made in sizes ranging in capacities from 150 cubic feet to 10,000 cubic feet per hour, and through multiple installation there is no limit to the conditions under which they can be used. The smaller sizes are used for domestic and commercial services and the larger sizes, either singly or in multiple, for field or industrial services of any range of capacity. Iron outer case meters can be made to operate under pressures of 500 pounds or even greater if desired.

Meters of this type require very little care, it simply being necessary to examine them at intervals of several years to see that the working parts are free from foreign matter and that the diaphragms are not bleached or damaged.

BEFORE CROSSING RIVER

Heavy clamp, weighing hundreds of pounds, is placed on pipe to help weight it when line is constructed across a river.



GASO RIVER CLAMPS

for GAS Lines

GASO River Clamps, manufactured by the Tulsa Iron Works Company, Foundry Division of the Gaso Pump & Burner Mfg. Co.,—are made of the same extra quality of castings that are used in making the famous Gaso Oil Industry Pumps.

Our clamps for gas lines have offset recesses for taking Dresser couplings, as indicated in the above illustration. These clamps are built extra heavy and are strongly reinforced at all points of strain. Each clamp is tested on the size pipe for which intended. Offered in sizes from 2 to 20 inches. The illustration shows the 16-inch size.

GASO Clamps have been used in the construction of many of the country's largest gas lines. We also manufacture a type for oil lines which is in equally wide use.

The Tulsa Iron Works Company maintains a fully equipped pattern shop, and handles a limited amount of jobbing work, such as piston heads, cylinders, and liners, for operating companies in its territory. Highest grade work is guaranteed. Your inquiry is invited.

TULSA IRON WORKS COMPANY
Tulsa, Okla.

TULSA IRON WORKS

FOUNDRY DIVISION GASO PUMP & BURNER MFG. CO.

SPECIAL ATTENTION!

Construction Engineers
Pipe Line Superintendents
Purchasing Agents

Several of our very good customers have notified us that unscrupulous paint organizations have approached them, offering as pipe line protective coating, claiming same to be identical with Eclipse Save-A-Line. In one instance, we are advised, one of these paint companies even went so far as to offer their goods under the trade name of Save-O-Line.

Eclipse Save-A-Line is the first, and only time-tested, elastic, asbestos impregnated, protective coating for pipe lines. Its use for over seven years by some of the largest gas and pipe line companies in the world, many of whom have absolutely standardized upon it and are constantly re-ordering, speaks volumes for the merits of our goods. It is manufactured strictly in accordance with our standard formula, perfected almost eight years ago.

Save-A-Line has no substitute of its kind. Don't be misled by flagrant misrepresentations that can only result to your disadvantage and loss.

Yours very truly,

The Eclipse Paint & Manufacturing Co.

President

ECLIPSE SAVE-A-LINE

Greatly Lengthens the Life of Embedded Pipe Lines

The ever-present, costly toll from corrosion to steel can be reduced to the absolute minimum by protecting embedded pipe lines with *ECLIPSE Save-A-Line.*

Save-A-Line is the perfect pipe line coating. It requires no heating or mixing in its application. It is a tough, extremely elastic, super-adhesive coating, composed of long-lived elastic vehicle, thoroughly impregnated with clean selected asbestos fibre.

With one application, *ECLIPSE Save-A-Line* gives a protective film equal to four or five ordinary paint coatings. It is a time-tested, thoroughly reliable protection.

The Lone Star Gas Company
Gulf Pipe Line Company
Humble Pipe Line Company
The Shell Co. of California
The Empire Natural Gas Company
The Wilmington Gas Company
The California Petroleum Company
The Public Service Electric & Gas Co.

When such nationally known, big buyers as those listed at left with pipe line investments running into hundreds of millions of dollars, purchase and reorder *Save-A-Line* regularly, you know it must have unusual merit—*long life at low cost.* What better proof of the long life and reliability of *Save-A-Line* could you ask?

SAVE YOUR LINES WITH *SAVE-A-LINE.* Let us send you sample and quote you prices. Write us.

The Eclipse Paint & Mfg. Co.

Cleveland, Ohio, U.S.A.

DALLAS DENVER TULSA NEWARK PHILADELPHIA
SPRINGFIELD, MASS. PITTSBURGH SAN FRANCISCO CHARLOTTE, N. C.

Orifice Meter in Measurement of Gas

Nontechnical Description of This Apparatus Given for Those Who Have Not Carefully Studied the Subject

By Dr. Archer E. Young
In Charge of Gas Measurement for Peoples and Affiliated Natural Gas Companies

The following description of the orifice meter is nontechnical in character and is intended primarily for the information of those who have not given particular study to this meter. For a mathematical treatment of the subject reference is made to:

"Measurement of Natural Gas" by Thomas R. Weymouth. Transactions of American Society of Mechanical Engineers 1912 Volume 34 No. 1,376.

"The Flow of Air Through Thin Plate Orifices" by Ernest O. Hickstein. Transactions of American Society of Mechanical Engineers 1915 Volume 37 No. 1,506.

"On the Commercial Metering of Air, Gas and Steam," by Hodgson—Proc. Inst. C. E. Vol. CCIV. 1926-17 Page 148.

In Figure 1 are two diagrams of an orifice meter as installed in a pipe line. When natural gas flows through the pipe, the meter records the rate of such flow and from this record the volume of gas which has passed through the meter in an hour, or any other period of time, may be computed.

Principle and Method

The principle and method of this system of measurement are very simple.

A suitable union consisting of flanges (A) and (B) is placed in a pipe line.

Between these two flanges is placed a thin plate (Z) and through the center of this plate a hole, smaller than the diameter of the pipe, is cut.

Suppose now that gas is turned into the line and flows in the direction indicated, (1) towards (2). The obstruction formed by the steel plate will cause a slight drop in the pressure of the gas as it flows through the hole in the plate. That is to say, the pressure of the gas on the upstream side (1) of the plate is a little greater than the pressure on the downstream side (2).

A small hole is drilled through the line on each side of the plate, one method of doing which is shown in Figure 1, then by connecting a glass U tube (E) between these holes, as shown, and by placing water in the tube, we can measure the difference of pressure as between the upstream and downstream sides of the plate. Thus when gas is flowing from (1) towards (2) we find that the water will rise in that leg of the U tube attached to the hole in flange (B), and will fall in the leg attached to flange (A).

If, for example, we find by measurement that the vertical distance between the level of the water in the two legs of the U tube is, say, 6 inches, the fact is usually stated by saying that the difference in pressure as between the two sides of the plate, "pressure drop," is equal to 6 inches of water.

Also a pressure gauge (F) is placed on the pipe for the purpose of determining the actual (static) pressure of the gas flowing through the line.

Note particularly that this gauge (F) is used in determining the "absolute" pressure of the gas flowing through the pipe line. Therefore, if the gauge (F) is of the usual type, when the pointer stands at zero the pressure of gas inside the pipe will be just equal to the atmospheric pressure surrounding the meter. For this reason, therefore, it is necessary to add the atmospheric pressure in pounds per square inch as indicated by a barometer to the reading of the gauge (F) in order to determine the "absolute pressure" required in gas flow computations.

In the foregoing outline we have described the three principal parts which together constitute an orifice meter. First, the steel plate in which the orifice is cut (Z) (See Figure 1); second, a means of measuring the drop in pressure through the orifice, U tube (E); third, a means of measuring the density, or static pressure, of the flowing gas, gauge (F).

Making an Orifice Meter

In making an orifice meter, as a first step, a capacity measurement of the orifice itself is made. This measurement consists in finding, by actual test, the volume of gas which will pass through the orifice in an hour of time (or in any other fixed period of time) when conditions show a "pressure drop" through the orifice equal to 1 inch of water, as indicated on the U gauge (E), and when at the same time the pressure as found by the gauge (F) is one pound "absolute pressure."

This measured volume of gas is called the hourly "Coefficient" of the orifice.

Thus, for example, it has been determined by test that the coefficient of an orifice approximately 2 inches in diameter, when used in a pipe line constructed of 4-inch pipe and arranged as shown in Figure 1, is 1,000 feet of gas per hour when the water reading of the U tube (E) is 1 inch "pressure drop" and the absolute pressure gauge (F) is 1 pound absolute. Then, 1,000 cubic feet is the "hourly coefficient" of this orifice.

Let this same orifice be placed in a pipe line passing natural gas, and a suitable U gauge (E) and static pressure gauge (F) conected. If it is observed that the U gauge (E) indicates a pressure drop of, say, 9 inches of water, and the gauge (F) indicates, say, 64 pounds absolute pressure, then the rate of flow of the gas may be calculated thus:

Multiply the indication of the water gauge (E) 9 inches by the absolute pressure indicated by gauge (F), 64 pounds, and take the square root of the product of these two observed values. As a next step, multiply this product as found by the coefficient of the orifice, namely, 1,000 cubic feet. The final product gives the rate at which the gas is passing through the orifice in cubic feet per hour. If all conditions remain steady and unchanged for 1 hour, then 24,000 cubic feet of gas will have actually passed through the orifice in that period. The foregoing is expressed by the following formula:

$$1{,}000 \text{ cubic feet} \times \sqrt{9'' \times 64} \text{ Lbs (absolute)} = 24{,}000 \text{ cubic feet per hour.}$$

Tables of Coefficients

Coefficients have been established for all the various diameters of orifices commonly used in each size of pipe line. The makers of orifice meters publish tables of these coefficients in their handbooks.

All published tables of coefficients usually state what is termed a "base" on which the numerical values of the

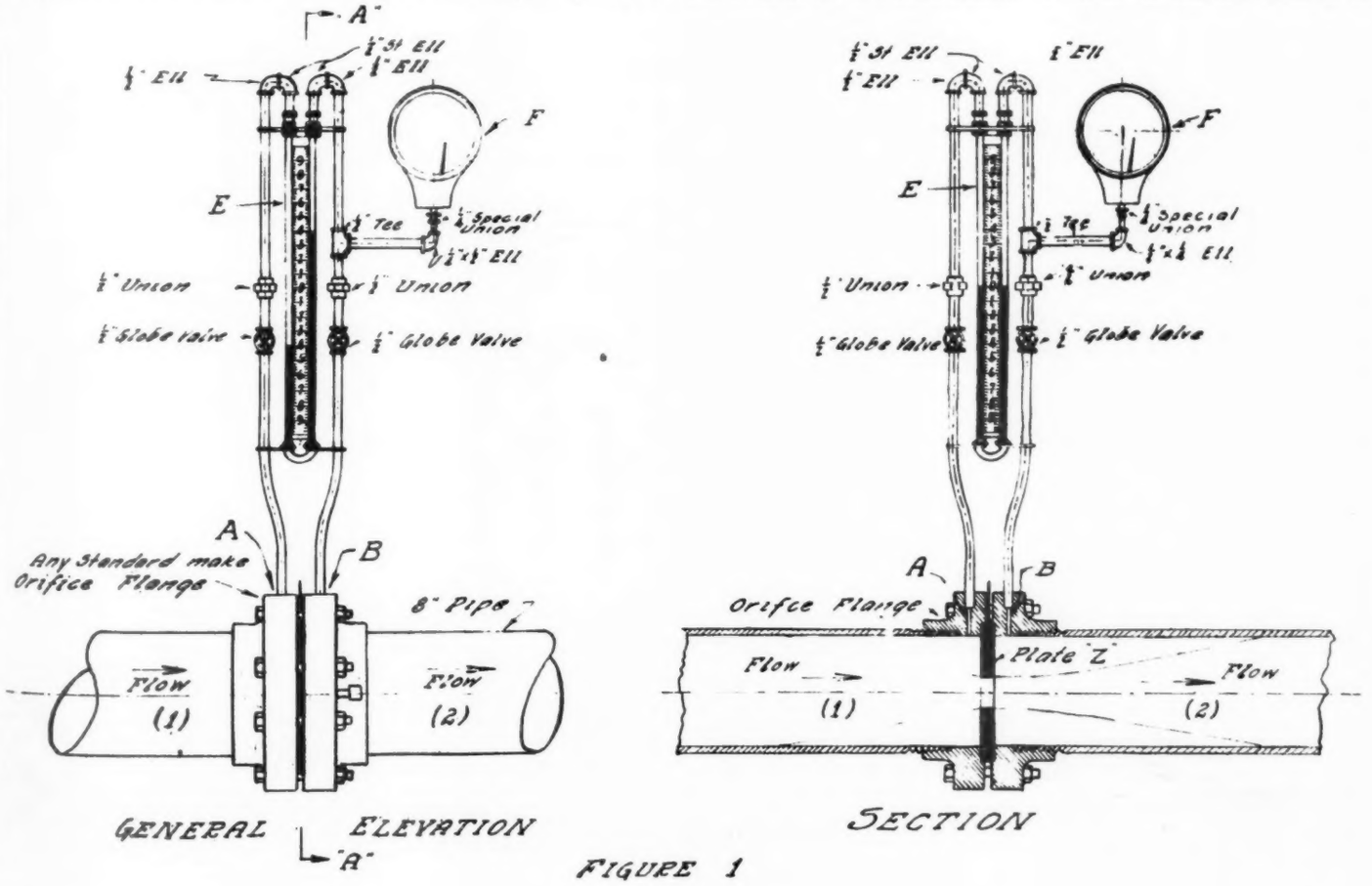


FIGURE 1

tabulated coefficients are calculated. This base contains four factors, viz:

A. Storage pressure in pounds absolute.

B. Storage Temperature degrees Fahrenheit.

C. Flowing Temperature degrees Fahrenheit.

D. Specific Gravity.

For example, a coefficient of a certain orifice may be stated to be 1,000 cubic feet per hour on the following base:

A=14.4 pounds Atmospheric Pressure plus 4 oz.

=14.65 lbs. absolute.

B=50 degrees Fahrenheit.

C=40 degrees Fahrenheit.

D=Specific Gravity .64.

The storage pressure and temperature —A and B—relate to the condition of the gas after it has passed through the meter, and considered as stored in a tank. If the meter is to be used for the purpose of measuring gas in a sales contract, then these two factors, A, pressure, and B, storage temperature, applied to the cubic foot of gas to be sold, are arbitrarily fixed by the terms of the contract. Therefore, if these provisions in the sales contract differ from the values A and B upon which the coefficient is based, a correction must be made in the coefficient so that its new value will be correct for the cubic foot described in the sales contract. The necessity for stating the values of these factors, A. B. C. D. may best be indicated by describing each.

A—Storage Pressure

Since gas is elastic it is apparent that a tank having a cubical dimension of, say, 1,000 cubic feet, may contain various weights of gas, depending upon the pressure at which the gas is held in the tank. Thus, if a gauge placed on such a tank indicates an absolute pressure of, for example, 15 pounds, we say the tank contains 1,000 cubic feet at 15 pounds pressure (absolute). If we put more gas into the tank until the gauge indicates 30 pounds absolute pressure, we still have 1,000 cubic feet (volume) of gas in the tank, but as the pressure has been doubled the tank contains the equivalent of 2,000 cubic feet of gas at 15 pounds density as first described.

Hence, in the tables of coefficients for orifices, referred to in the foregoing, the pressure upon which the coefficients are based is given. For example, the coefficient of a certain orifice may be 1,000 cubic feet at 14.4 pounds plus 4 ounces. Therefore, calculations based on that coefficient will give the result in volume at that pressure.

B—Storage Temperature

As noted in the foregoing, the values for coefficients state a storage temperature, for example, 50 degrees Fahrenheit, or 60 degrees Fahrenheit, upon which the coefficient is based. This is necessary since gas expands with rise in temperature.

Thus, consider again the tank having a volume dimension of 1,000 cubic feet. If filled with gas at, say, 50 degrees temperature and 15 pounds absolute pressure, then if by some means the temperature is raised to 60 degrees Fahrenheit the observed pressure will also rise, so that it will be necessary to withdraw some of the weight of gas from the tank in order to hold the observed pressure at 15 pounds absolute pressure.

Hence it is apparent that to refer to a volume of gas, say of 1,000 cubic feet, at 15 pounds absolute pressure, is not a complete description, but the temperature also must be stated to determine the actual weight of gas in the volume.

C—Flowing Temperature

Also, the tables give a temperature for the gas as it passes through the orifice plates and state that the value of the coefficients are based upon that "flowing temperature." This is necessary because gas of 60 degrees temperature is less dense than gas of, say 50 degrees temperature. Therefore, when flowing through an orifice, suppose, for example, that the temperature of the gas is 60 degrees Fahrenheit and that it is passing at such a velocity as to cause a pressure drop of 9 inches of water. Under these conditions a certain volume, say 1,000 cubic feet per hour, will come to rest in storage at a certain pressure and storage temperature. Now if the gas when passing through the same orifice is at 50 degrees temperature and still shows 9 inches water drop in pressure, the volume which will come to rest in storage will be 1,010 cubic feet in an hour's time instead of only 1,000 cubic feet when figured at the same storage pressure and storage temperature as before. The same force, a drop in pressure equal to 9 inches water, will give a greater velocity to the gas of 60 degrees Fahrenheit than to gas of 50 degrees Fahrenheit when moving through the same orifice, but in the latter case, the weight of the gas passed will be greater and hence the storage volume will also be greater.

Therefore in using an orifice, if the flowing temperature of the gas differs from that upon which the coefficient is based, it is necessary to apply a correction factor to the volumes so computed.

In practice, because the temperature of the gas flowing through the buried pipe lines does not change rapidly, this temperature in many cases is determined at the beginning of operation of a sales contract, the coefficient corrected accordingly, and after that the temperature is assumed constant at that fixed value. In other cases more frequent observations and corrections are made.

D—Specific Gravity

One other factor, namely, specific gravity of the gas, is stated in describing the base of a coefficient for an orifice. The weight of air is used as a standard for reference in stating the specific gravity of other gases. Suppose 1,000 cubic feet of the natural gas taken from a certain field weighs 47 pounds when at 60 degrees temperature and 14.7 pounds absolute pressure. Then 1,000 cubic feet of air at the same pressure and temperature will weigh 76 pounds. Therefore the gas weighs .62 of the weight of air and this ratio is its "specific gravity."

Now if the gas passing through an orifice plate is moving at such a velocity as to produce a drop in pressure equal to 9 inches of water as shown by the U gauge, and has a specific gravity of say, .64, then if another and heavier quality gas having a specific gravity of .70 is passed through the same orifice, at the same drop in pressure, viz., 9 inches water through the orifice, this latter heavy gas will be moving at a slower velocity than the former light gas of .64 specific gravity.

In practice, therefore, since the coefficient of the given orifice is necessarily based on gas of a stated specific gravity, then if the gas to be measured is heavier, or lighter, than this stated specific gravity, the value of the coefficient must be corrected accordingly.

The method and formula used in making corrections to the values of the coefficient of an orifice so as to change it from one set of base values, A, B, C, D, to another set of base values is shown as follows:

"A"—Storage Pressure Change

To change to a new storage pressure multiply the coefficient in use by the pressure in use and divide the result by the new pressure.

For example, if 1,000 is the old coefficient figured on a storage base of 14.4 plus 4 ounces (14.65 lbs.) then figured on a new base of 14.4 plus 8 ounces (14.9 lbs.), the new coefficient $=1{,}000\times\frac{14.65}{14.9}=$ 983 cubic feet per hour (approx.)

"B"—Storage Temperature Change

To change to a new storage temperature, multiply the coefficient in use by new temperature plus 460 (to get absolute temperature) and divide the result by the old storage temperature plus 460.

Thus, if 1,000 is the coefficient in use figured on a storage temperature of 50 degrees Fahrenheit then figured on a storage temperature of 60 degrese Fahrenheit the new coefficient $=1{,}000\times\frac{60+460}{50+460}=1{,}020$ cubic feet per hour (Approximately.)

"C"—Flowing Temperature Change

To change to a new flowing temperature, multiply the coefficient in use by the square root of the old flowing temperature plus 460 and divide the result by the square of the new flowing temperature plus 460.

Thus, New Coefficient $=1{,}000\times\frac{\sqrt{40°+460}}{\sqrt{60°+560}}=1{,}000\times\frac{\sqrt{500}}{\sqrt{520}}=981$ cubic feet per hour (approximately), where the old flowing temperature was 40 degrees and the new 60 degrees.

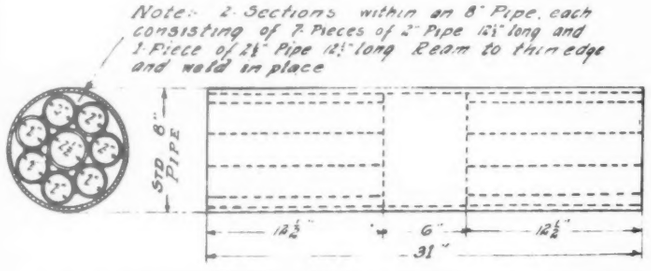
"D"—Gravity Change

To change to a new gravity, multiply the old coefficient by the square root of the old gravity and divide the result by the square root of the new gravity.

Thus, New Coefficient $=1{,}000\times\frac{\sqrt{.64}}{\sqrt{.60}}=1{,}033$ cubic feet per hour (approximately) where the old gravity was .64 and the new .60.

Flowing Pressure—Barometer

When an orifice meter is set to measure natural gas, it is general practice to assume that the atmospheric pressure at the location of the meter is constant. Hence, in determining the absolute pressure for Gauge F—Figure 1—this fixed value is added to the observed gauge reading. While it is true that the barometer will vary from time to time at the meter location, these variations are not of sufficient magnitude or duration to affect the results materially, hence the fixed barometric value is generally used.


Note:- 2 Sections within an 8" Pipe, each consisting of 7 Pieces of 2" Pipe 12½" long and 1 Piece of 2½" Pipe 12½" long Ream to thin edge and weld in place
8"
STD PIPE
12½"
6"
12½"
31"

STRAIGHTENING VANES ORIFICE CONNECTION

Suggestions Offered

The Natural Gas Association of America has appointed a committee on gas measurements. The personnel of this committee consists of engineers and scientific men connected with some of the larger natural gas companies and also physicists of the United States Bureau of Standards and Engineers of the Bureau of Mines. This committee is making a thorough study of the orifice meter as widely used in the natural gas business and ultimately will report in such a form that the industry can obtain full information as to the proper method of installing orifice meters and the correct method of operating them. The following suggestions for operating and installing meters are therefore offered only in a primary way. It is to be understood that these suggestions are made subject to any corrections or changes which the committee mentioned in the foregoing may later determine.

Operation of Meters

The orifice plate should be removed from the pipe line and examined and cleaned at intervals which, in the judgment of the operating engineers, will give satisfactory results.

The work of removing an orifice plate and replacing same is small and, for that reason, examinations can and should be made frequently.

The apparatus by which the pressure drop "E" is recorded should be examined every day. If mercury floats are used for this purpose, these should be balanced at least once each month, but on meters measuring large quantities of gas, balancing should be done at more frequent intervals. Such matters should be determined by the operating engineer.

The reading of recording charts should be done at 15 minute intervals for meters equipped with recording instruments. This gives 96 simultaneous readings of the pressure drop and static pressure per day. Experience indicates that in general this number of readings will cover ordinary irregularities of flow with sufficient accuracy. Extreme irregularities of flow may require readings at even shorter intervals.

The orifice meter will make practically accurate measurements of natural gas flowing through a pipe line providing the following important matters are carefully attended to.

To Assure Accuracy

First. The several factors, A, B, C, D, before described which affect the value of the orifice coefficient must be accurately determined, and from time to time modified as changes in specific gravity or temperature require.

Second. The recording apparatus must be reliable and accurate and must be handled and maintained with proper care.

Third. The flow of gas through the orifice should be regulated so that the pressure drop across the orifice as measured in inches of water should never exceed, numerically, the absolute pressure of the gas as measured in pounds absolute pressure. Thus, if the absolute pressure is say, 50 pounds, then the water reading "pressure drop" should not exceed 50 inches. This rule is especially important for conditions where the pressure is 50 pounds or less. On the other hand, the flow of gas through the orifice should be regulated so that the pressure drop shall not be less than sufficient to produce a water reading of 4 inches, as slightly incorrect readings cause too great inaccuracies in results.

Fourth. In case an orifice is to be used to measure gas under widely varying conditions as to combinations of pressure and rates of flow, the diameter or the orifice should not exceed one-half the diameter of the pipe in which it is used.

Fifth. Experience at present shows that disturbance causing pulsations in the gas stream must be eliminated so far as practically possible. Such disturbances are caused by fittings, elbows, or tees placed near the orifice. Fittings as noted should not be placed closer to the orifice than shown in the following table:

Size of pipe inches	Straight Run Up-Stream Side feet	Straight Run Down-Stream Side feet
4	18	8
8	36	16
10	45	20
16	72	32

Should it be absolutely necessary to have fittings closer than above table shows, then straightening vanes should be set in the pipe.

Pressure regulators should be kept as far from orifice meters as possible, but, if necessary to set them nearer than a distance of 100 feet upstream, straightening vanes should be used.

The straightening vanes referred to have been designed various ways; one type which has given satisfactory results is shown in the accompanying figure.

KEEPS ICE HOUSE WARM

Logan Cary, gas superintendent for the Oklahoma Gas & Electric Co., tells of an interesting installation in New York State. Mr. Cary says that though competition between the gas and coal men in Tonawanda, N. Y., is very bitter, one of the coal dealers harvests ice on near-by lakes in the winter for his summer trade but uses a gas boiler in his ice house in extreme weather to keep the temperature at 28 degrees above zero to avoid loss on account of the extreme brittleness of ice at below zero temperature.

Sullivan Portable Compressor and Sullivan Busters cutting concrete to repair a pipe line.

Speed Up With Air

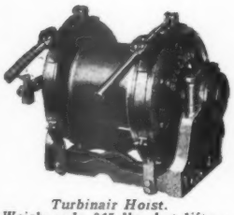
Your trenching, pipe laying, and tank erecting will go quicker and cost less money if you use Sullivan Air Power Equipment.

"WK-312" 110-ft. Compressor on steel wheels. Catalog 1583-D.

Sullivan Portable Air Compressors are built in 103, 110, 160, 206, 220 and 310-ft. capacities, for running your concrete breakers, rock drills, clay diggers, riveters, sheet pile drivers, and hoists. They are available, mounted on steel wheels, rubber-tired trailer trucks, skids, or your own truck.

Dependability is built into the Sullivan Compressor. Vibration and consequent wear are almost entirely eliminated by perfect balancing of reciprocating parts. The large models have balanced "V" cylinders. Drive is by the well-known Buda gasoline engine or by electric motor.

The 110-ft. compressor will run a heavy concrete breaker, 3 clay diggers, a heavy rock drill, 3 riveters, or a sheet pile driver, and has a hoisting capacity of 1000 lbs. *Write for Catalog 1583-D.*



Turbinair Hoist. Weighs only 345 lbs. but lifts a ton or pulls a 50-ton car. Catalog 1576-F.

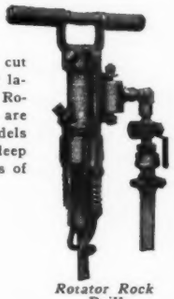
Sullivan Portable Hoists are inexpensive, but powerful little machines, for laying pipe or hoisting materials on construction jobs. Single and two-drum air and electric models are available. *Write for Catalog 1576-F.*

48-lb. and 75-lb. Busters are available, light models for cutting light concrete or asphalt, and the heavy, for smashing the hardest reinforced concrete. It is not unusual for these tools to reduce the hand labor cost on pavement cutting 48 to 60%.

Concrete Buster Catalog 1581-I.

Clay Spaders take the place of picks and shovels. They'll cut your clay digging labor cost in half. Rotator Rock Drills are available in 7 models for shallow or deep holes, in all kinds of formation.

Clay Spader Catalog 1581-J.



Rotator Rock Drill Catalog 1581-F.

COMPRESSORS · AIR LIFT · COAL CUTTERS · DIAMOND CORE DRILLS · ROCK DRILLS
PORTABLE HOISTS · DRILL SHARPENERS AND FURNACES · BUSTERS · SPADERS

SULLIVAN TRADE MARK
MACHINERY COMPANY
88 EAST ADAMS STREET, CHICAGO

Distributors in all principal cities: Consult your local phone book under Sullivan Machinery Company.

Chemicals in a Hurry at Lowest Cost

Spot stocks:

SODIUM ALUMINATE
TRI-SODIUM PHOSPHATE
SODA ASH
CAUSTIC SODA
CALCIUM CHLORIDE
CHLORINE
CHLORIDE OF LIME
MURIATIC ACID
FULLERS EARTH
AMMONIA
IRON SULPHATE
ALUM
SULPHUR

SPECIAL PRICES FOR JUNE SHIPMENT ON THE FOLLOWING:

Oil Refiners Litharge ..... $8.75 cwt.
Chloride of Lime ..... $3.75 cwt.
Sodium Aluminate ..... $9.75 cwt.

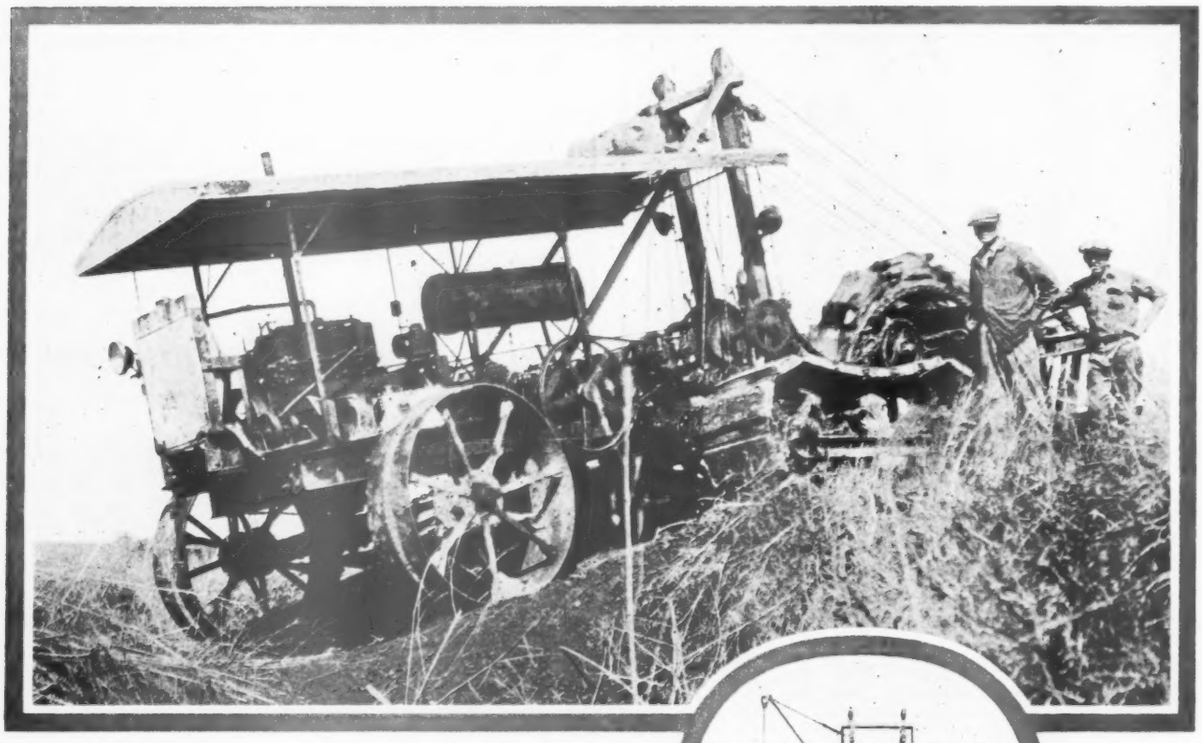
Ward Chemical Company
TULSA, OKLAHOMA
Telephone 2-1877

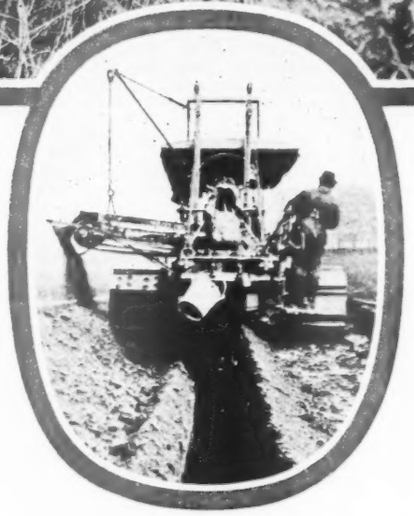
We specialize in the financing of Natural Gas Companies

Zwetsch, Heinzelmann & Company
Inc.

57 William Street New York
Telephone, John 3676

"We have found Buckeyes best"





THE OKLAHOMA CONTRACTING COMPANY, Dallas, Texas, is one of the most prominent and successful pipe-line construction companies. For over nine years they have used Buckeye pipe-line trenching machines. Some of these ditchers are that old in their service. Recently they bought three others, *giving them thirteen Buckeyes in all.*

Asked about the performance of these ditchers, they replied: "Each cuts 1500 to 3000 lineal feet of trench, 15″ to 24″ wide, 24″ to 54″ deep in 8 hours. One machine equal to 100 men. Superior features are—wheel type, weight and power. By past experience with other makes *we have found Buckeyes the best.*" A wonderful testimonial, *but* a Buckeye will do that kind of work—for you as well as for them.

Write for the free booklet "Pipe-Line Construction Records." It gives other reasons why Buckeye leadership in the oil field is unquestioned.

Standardized Parts

"Our best argument in favor of Buckeye is that we can use parts bought for our newest machines on the older machines. In other words, Buckeye has kept their parts very well standardized over all the years they have built machines."

OKLAHOMA CONTRACTING CO.

THE BUCKEYE TRACTION DITCHER COMPANY

Manufacturers of Pipe-Line Trench Excavators

FINDLAY, OHIO

There's a Buckeye Sales and Service Office Near You

Buckeye TRENCH EXCAVATORS FOR OVER 30 YEARS

Unique Features in Baton Rouge Line

Country Traversed by 175-Mile Line From Monroe Included Swamps and Hills Devoid of Stones. Crossed Mississippi River

By E. C. Olds

On the morning of January 3, 1927, seven months after the arrival of the first pipe on the job, natural gas from the Monroe Field, in northern Louisiana began to flow through the burners of the Standard Oil Co. of Louisiana refinery at Baton Rouge, several weeks earlier than had been expected by those concerned in the realization of this interesting new 170-mile line of the Interstate Natural Gas Co., Inc. The purpose of this brief article is to present with the aid of a few photographs the features of the undertaking which were somewhat unusual and, therefore, of interest to the gas fraternity.

Apart from land and right of way matters the project divided naturally into five phases: (1) The compressor station at Fowler, La., northwest of Monroe; (2) the 89 miles of low level and more or less wet land from the station to the Mississippi River crossing south of Vidalia, La., and Natchez, Miss.; (3) the river crossing itself; (4) the 40 miles of rough country immediately south of the crossing and finally, (5) the 40-mile homestretch to Baton Rouge through gently rolling, ideal pipe line country.

The Station

The main field compressing station is located at Fowler in almost the exact center of the Monroe gas field. At present the station contains four 1,300-horsepower twin tandem Worthington compressing units, gas engine-driven, but provision has been made for its future enlargement. An interior view of the station is shown in photograph No. 2.

The station is not dissimilar in type to several large stations previously constructed in Texas, but has several details of design and construction that differ from previously accepted practice.

The roof and walls are of corrugated asbestos cement boards, considered better adapted to climatic conditions in Louisiana than the galvanized iron sheathing which has heretofore been considered standard. There are but few high-pressure gas pipe joints inside the building, the suction and discharge gate valves and bypasses being located outside of the building and handled by extension stems and gearing from handwheels inside the compressor room.

Cooling water of excellent quality was fortunately obtainable from artesian wells drilled on the station grounds, and it passed through the compressor jackets and closed type tubular coolers by pressure from an overhead storage tank of 200,000 gallons capacity.

Deep-well centrifugal pumps driven by electric motors deliver the water into the tank against a head of about 100 feet.

Electricity for pumping and lighting is provided by an auxiliary plant consisting of three 75-k.w. alternating current generators each driven direct by a 100-horsepower, four-cylinder Bruce-MacBeth gas engine.

A completely equipped machine shop was installed to facilitate repair work, as the station is located far from any commercial shop with proper tool equipment. A separate building contains shower baths and locker room facilities for the operators, as well as a storeroom for engine repair parts. The buildings are shown in photograph No. 1.

The main compressing unit foundations are carried on a heavy slab of reinforced concrete supported on piles. The subsoil is alluvial, requiring this expensive type of construction to prevent vibration of the entire structure during operation.

The location of the station, 15 miles from Monroe, made it necessary to construct a village to house the operators and their families. This was laid out with a broad graveled main street, the homes being well built with modern sanitary facilities and large screened porches, or galleries as they are known in the South.

Gas, artesian water and electricity are supplied from the station; trees, vines and flowers are being planted and after a few months the station should be quite a beauty spot, among surroundings not noted for scenery or society.

A concrete swimming pool supplied with flowing cool artesian water was built largely by the efforts of the employes and is a busy scene during the hot summer months.

Low Land

Ten miles south of the station, the main line of 22-inch coupled pipe, encountered Bayou LaFourche, a 3-mile stretch of swamp, which during six months of the year is completely submerged. During the summer months when construction took place, it was entirely dry. As a measure of precaution the line was divided through the swamp into four 13-inch screw lines, as shown in photograph on cover of this special insert.

Similar conditions prevailed for shorter distances at several other points on this section of the line, and were met in the same manner. Multiple lines were also used in crossing the navigable streams, such as the Tensas and Boeuff Rivers, where the lines were dragged across by the usual methods and sunk in a dredged trench to a sufficient depth to meet the requirements of the United States Engineers, who supervised the work.

Mississippi River Crossing

The Mississippi River crossing 3⅝ miles south of Natchez presented the most difficult problem on the entire line. The point selected, between the Whitehall plantation on the west bank and Carthage Landing on the east, is undoubtedly the best crossing site available between Vicksburg and Baton Rouge. At this point the river is practically straight for several miles, while over the period of the past 40 years the banks have been altered very little by the usual caving and making process, which threatens the existence of all structures along this great stream. Furthermore the bed of the river at the site selected is almost flat, with an easy grade on each side; the adjoining lands are admirable for the construction of the land terminals of the multiple lines with the headers and gate houses, and the site is sufficiently removed from the city of Natchez to be free from any of the risks arising from river navigation.

The quipment employed consisted of a work barge with open runway in one end, several sets of lowering pontoons and tugs as shown in photograph No. 4. There were also material and landing barges, a dredge for the excavation of approaches and several motor tenders.

The work barge, held against the current by tugs, dragged itself across the river by lines attached to a series of anchors set in an arc curving upstream to a maximum of 1,000 feet from its base. The pipe, 10-inch, 10-thread screw pipe, was screwed up and fitted on the barge with one 1,600-pound river clamp to each joint and as the barge proceeded the lowering pontoons served to govern the gradual settling of the line to the bed of the river without strain. The actual screwing up of the pipe was very carefully started by hand and completed by a pipe machine mounted on a caterpillar tractor on the deck of the work barge.

To provide against possible leaks in the river lines, each joint was tested just before laying to a hydraulic pressure of 500 pounds per square inch, and a collar leak clamp was applied to each coupling before the heavy river clamp was bolted on. Not even the smallest bubbling leak has yet appeared in any of the submerged pipe.

The year 1926 proved to be very exceptional so far as river conditions were concerned, so that it was necessary to begin the crossing work with a river stage of 29 feet when 5 to 10 feet was the usual stage for the season. The additional force of the current was met by the use of more tugs, heavier lines and large anchors built of concrete and railroad iron. However, the greatest menace to river work in the periods of high water, the vast amount of drifting logs and trash, finally compelled the suspension of work after four lines had been completed and the remaining lines will be laid as soon as a settled low water stage is reached during the coming summer. The finished lines average about 4,100 feet in length from bank to bank, but because of the long approaches on each side the total length of each of the multiple lines is approximately 7,500 feet.

The Mississippi Hills

Coming out of the river the line entered the rough wooded hills stretching south through Mississippi for 40 miles from Natchez. These hills are peculiar in the almost total lack of stone, the soil being a firm mixture of clay and sand which readily lends itself to deep ditching by hand. Photograph No. 5, shown on cover of this insert, is interesting as showing the possibilities of this type of soil. These ditches were cut in some places to as great a depth as 28 feet through the crests of the low hills, with bellholes for tightening bolts after lowering the pipe. Contrary to usual practice the laying of the line through these small hills and ravines proceeded steadily forward and the sags in the bottoms of the ravines were set as they were reached, the weight of the pipe on the down slope being carried by wooded horses. There has been nothing to indicate any weakness in the line resulting from this method.

About midway among these hills the Homochitto swamp presented very great difficulty. This swamp is crossed by a number of small swift streams and is never entirely dry as is the LaFourche Bayou in summer. Also these streams are subject to very rapid rises after rains. To meet conditions here a very unusual and interesting plan was followed. After the right of way had been cleared and stumps blasted large numbers of cypress saplings were cut and laid across the right of way about a foot apart. Over these a simple plank track was laid, as shown in photograph No. 6, over which the pipe was carried by truck for stringing and materials and men taken into work. The pipe was put together on top of the mat of saplings and when all the pipe was in place the saplings were cut and removed, the high spots ditched and the pipe settled into the swamp. River clamps were also used here to weight the pipe.

Easy Going

The remainder of the line into Baton Rouge offered no difficulties whatsoever, being gently rolling or flat dry meadow land. The only remarkable feature of the work here was the speed of nearly a mile a day of completed line accomplished through the use of mechanical equipment.

In fact the nature of the soil throughout practically the entire route of this line was such as to permit the use of mechanical equipment to an extent probably not equaled in any previous line. This soil being largely gumbo could be ditched very cleanly in the dry season, so as to leave clean cut sides and firm banks. Each gang was, therefore, equipped with a ditching machine, pipe crane, such as illustrated in photograph No. 7, and backfiller. It was only through such complete equipment that the very unusual speed of this undertaking was made possible.

Photograph No. 8, on cover of this insert, shows a section of the pipe coupled and coated ready for lowering.

Pipe Protection

After very extensive and careful investigation of the various types of pipe protection which have been employed on lines throughout the southwestern section of the country and a study of soil conditions along the route to be followed three different coatings were finally selected. On the gathering lines in the field No-Ox-Id was used; on the northern half of the line from the station to the Mississippi River, Biturine; and from the crossing to Baton Rouge, Bitumastic.

In each case the pipe was first thoroughly brushed with steel wire brushes to remove scale. When the metal was clean and dry No-Ox-Id was applied to the surface with brushes and after being well brushed into the pores, a substantial film was left, over which the No-Ox-Id wrapper was laid and cross lapped. In applying Biturine the clean pipe surface was first given a priming coat of Biturine solution applied cold, followed by a hot coating of Biturine enamel applied by the canvas method. The application of Bitumastic solution and enamel was the same as that just described except for the ingenious device shown in photograph No. 9 for revolving the pipe during the application of the enamel, thus securing an even thickness over the entire surface with a minimum wastage.

The soil analysis indicated the absence of chemical substances which might promote corrosion. The chief problem to be faced, therefore, was the periodic extreme saturation of the soil followed by extreme heat, drought and soil contraction. These conditions necessitated a coating that should be at the same time flexible, impervious to moisture and tenacious to the pipe rather than to the soil. With such characteristics and barring imperfections in application and injury in handling, the maximum possible protection should be realized under the given conditions. For this reason the results of future inspections of this line will be awaited with keen interest.

River Transportation

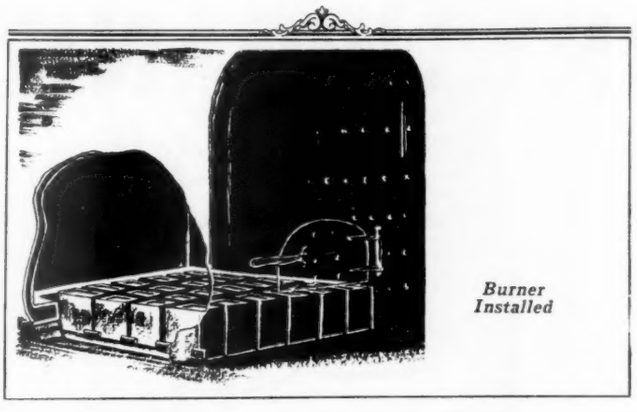
The accompanying photograph No. 10 illustrates the manner in which river transportation was employed as an aid in the construction of the line. Much of the pipe used in the southern half of the line was barged down the Ohio and Mississippi Rivers from the Pittsburgh district to the river crossing at Natchez and to Baton Rouge, and trucked from the unloading points to its final destination on the line. This photograph is of particular interest both in its illustration of the manner in which the pipe was stacked on the barges, and the condition of the river bank at the crossing site at a time when the river stage was only 7 feet. This picture was taken at Carthage Landing, Miss., at the east end of the river crossing. Altogether nine barge loads of pipe were brought down the river for this work.

The design and construction of the pipe lines, stations, swamp and river crossings were under the charge of Ford, Bacon & Davis, Inc.

1
2
4
7
9
10
6
Taking
NATURAL GAS
from
MONROE TO
BATON ROUGE

"Have you heard about the Perfecto Gas Burner?"
"That's the burner Fletcher is urging us to adopt, isn't it?"
"Yes, we're using it at Seminole now and it's doing wonders on the low gas pressure."

"—have you heard about the PERFECTO *Low Pressure* GAS BURNER?"

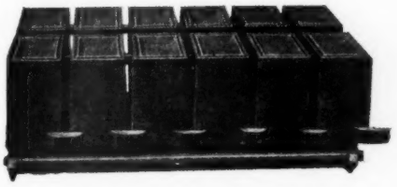


Burner Installed

Oil Men everywhere are interested in the betterments and economies which the Perfecto Burner brings. So the story of how in less than two years this burner has risen to the position where it is being used by over 42 of the leading producing companies, is one of the most profitable subjects discussed in oil circles today. The Perfecto Low Pressure Gas Burner cuts production cost because it generates the *greatest* amount of heat with the *lowest* gas consumption and the lowest boiler repair expense.

Develops Working Steam Pressure On Low Gas Pressure

The Perfecto Burner generates steam pressures of 150 to 175 lbs., on gas pressure varying from as low as 2 to 10 lbs., three simple reasons explain why. *First.* The Perfecto Burner gives perfect combustion—gets *all the heat* from the gas burned. Nothing is lost. It makes a hotter fire. *Second.* In its flexible "unit" form the heat is evenly distributed over the entire fire box—the closest possible approach to a well laid coal fire. *Third.* The burner converting all the gas develops a hot blue flame—producing the highest efficiency known.



Perfecto is patented in the U. S. A. and Canada. Patent pending in India.

Perfecto Burners Are Installed by Our Own Experts

Each Burner is installed, tested and inspected by men trained in the installation and service of Perfecto Burners. It is guaranteed for a period of one year and should any defect develop during this time it will be replaced without charge.

In most instances we have representatives located close to the large producing fields making installation a matter of but a few hours.

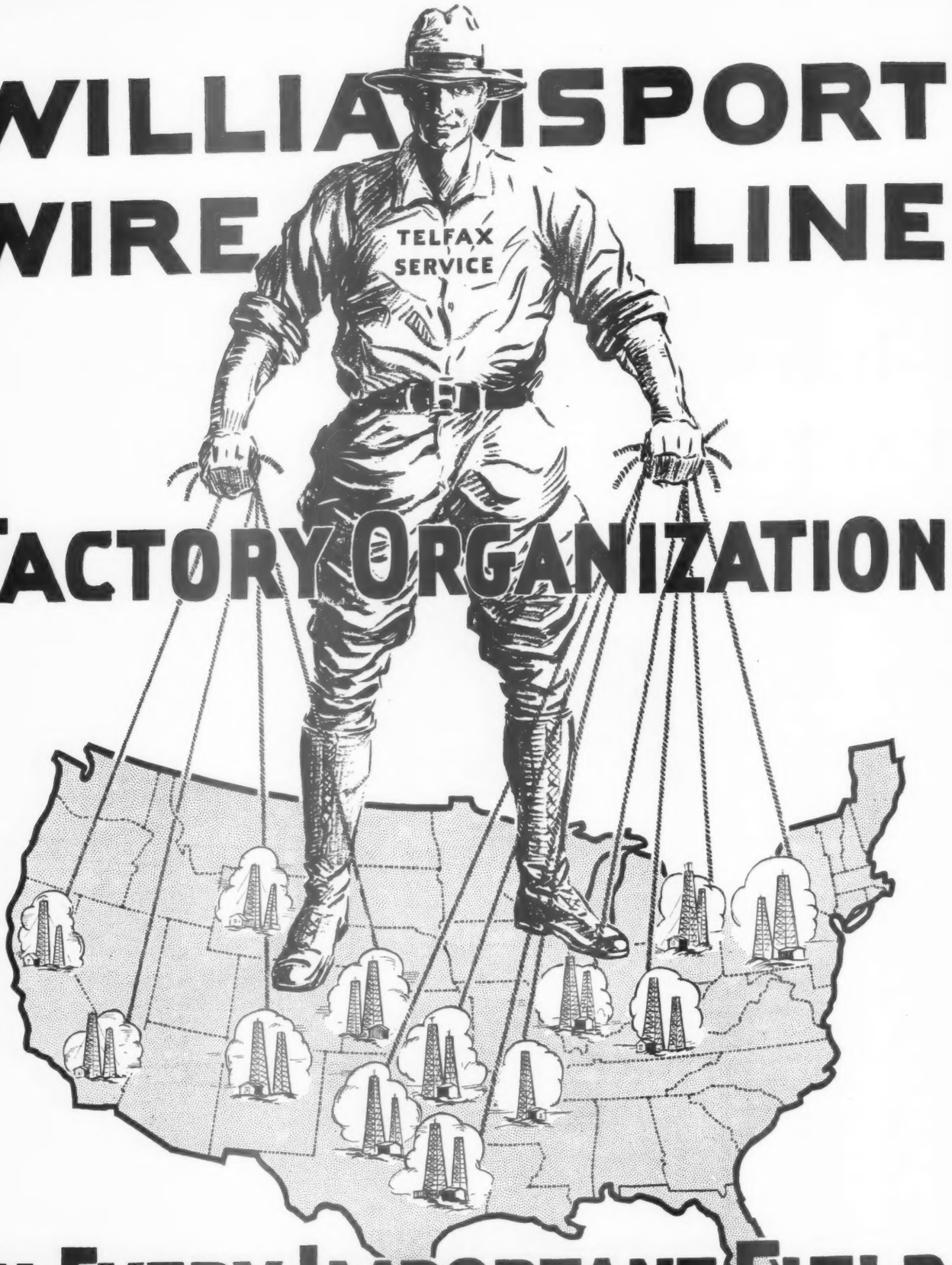
Let us send you the facts NOW. What the Perfecto Burner is doing for others it will do for you. Write, wire or phone today, it may mean the saving of thousands of dollars to *YOU*.

LOW PRESSURE PERFECTO GAS BURNER

THE P. J. SONNER GAS BURNER COMPANY, WINFIELD, KANSAS

Sales and Service at: Los Angeles, Calif. Borger, Texas Wichita Falls, Texas Tulsa, Okla. Shawnee, Okla. Pampa, Texas

WILLIAMSPORT WIRE LINE



FACTORY ORGANIZATION

IN EVERY IMPORTANT FIELD

Williamsport Wire Rope Company

Main Office and Works: Williamsport, Pa.

General Sales Offices: 122 S. Michigan Ave., Chicago, Ill.

Oil Country Sales Offices: Williamsport Bldg., 4th and Midland Valley Tracks, Tulsa, Okla.

Distributors: Houston, Mildred, Shidler, Blackwell, Ardmore, Holdenville, Bristow, Wichita Falls, Bartlesville, Smackover, Arkansas City, Cromwell, Shreveport, Casper, Lewistown, Electra

Use Madesco Tackle Blocks, They Stand the Gaff.

Natural Gas in Gulf Coast Territory

Much of the Commercial Production Has Been Developed in Southwest Texas. Active in Pipe Line Building

By A. S. Henley
Chief Geologist, Houston Oil Co. of Texas

In preparing this article much of the information has been taken from reports on the area made by Fred P. Shayes, P. H. Martyn and J. B. Best, of the geological staff of the Houston Oil Co. of Texas, who have spent practically all their time during the past two years in this area.

Practically all the commercial gas so far found in Southwest Texas is in an area beginning at Laredo, in Webb County, Texas; down the Rio Grande to Rio Grande City; thence easterly to the Gulf of Mexico; along the coast to the mouth of the Lavaca River; northwesterly to Edna, in Jackson County; southwesterly to Callaham, in McMullen County; and thence southwesterly to Laredo.

In this area are the producing gas fields of Refugio, in Refugio County; White Point in San Patricio County; Saxet in Nueces County; Lucas in Live Oak County; Three Rivers in Live Oak and McMullen Counties; Kingsville in Kleberg County; Cole-Bruni in Duval and Webb Counties; St. Albans in Jim Hogg County; Carolina-Texas in Webb County; and Jennings in Zapata County.

Areas from which some gas has been produced and which may develop into production again are (1) An area west of the town of Mathis in northwestern San Patricio County; (2) Enda Field, in Jackson County.

Located on Uplifts

These gas fields seem to be located on uplifts, of an anticlinal nature, with the major axis running nearly north and south. Production on these highs is governed almost entirely by sand conditions; that is, where a porous sand is found on the uplift, gas wells of from 10,000,000 to 90,000,000 feet daily open flow capacity are brought in. Many wells drilled on locations favorable as to structure find no porous strata, and are dry.

There are very few dependable indications of surface structure. Most of the wells have been located because of gas showings in shallow water wells or on topographic highs. Owing to the character of the surface material, and existing information, local dips, or the correlations of sands in shallow water wells, are very misleading. The best surface reflection of subsurface structure is found at Lucas, in Live Oak County, where a large inlier of Oakville sand is found protruding through the overlying Lapara, Lagarto and Reynosa formations. However, production has not followed the outlines of this inlier because of the lenticular nature of the sands in the producing horizon.

Many of these fields lie along the Reynosa Escarpment, and there has been considerable discussion as to the relation of this escarpment to production. Early observers were of the opinion that production was only found along the escarpment, and to the west of it, but later drilling has shown that its value as a pointer toward producing areas was very slight.

Refugio Field

The first drilling in the Refugio gas field was done by the Texas Gulf Oil & Gas Association in 1919, and was brought about because of the finding of gas and sulphur water in shallow wells in the vicinity. The well blew out and ran wildly for some time, but was finally killed, but the hole was in such bad shape that it was abandoned. Soon after this the Pratt-Hewitt Oil Co. entered the field and drilled several wells, all of which blew out at some time during the drilling. The history of the early drilling shows an enormous waste and an utter disregard for the conservation of the gas. It was not until August, 1925, that a well was brought in in the field without having one or more blowouts, and consequent wastage of gas. The best known of these blowouts was what is known as the Smith well on the Wilson Heard 250-acre tract. This well ran wild for 39 days, and gauged 72,000,000 feet daily after it was brought under control. This shows an estimated loss of 2,800,000,000 cubic feet of gas from this one well. It is estimated that at least this much more gas was lost into the air from the other wells which have blown out, beside the underground wastage which much have occurred from the escape of gas into the upper water sands.

There are no surface indications of subsurface structure, and the only marker which has been found constant over the area drilled has been what has been termed the 2,400-foot sand. This shows an elongated dome with the long axis running north and south, with at least 40 feet of closure. The dip to the east seems to be more gentle than that to the west.

No faults have been recognized in this field and none is necessary to explain the accumulation of gas, so it is considered that none is present.

Producing Horizons

Production has been obtained from sands and sandy shales at the 1,400, 1,600, 1,700, 1,850, 2,100, 2,300 and 2,400-foot levels. Of these horizons, the 2,400-foot sand has been the most prolific, but at the present time it is almost exhausted. The shallower sands are lenticular and grade from sands to shales in short distances. Owing to blowouts and improper casing methods in the early development of the field these sands have in many instances become watered, and seem on the whole to be short lived.

Two wells have been drilled to a depth of around 4,600 feet. The first of these blew out and was lost, but it is impossible to say whether the gas came from the bottom of the hole or from some shallower sand. The second well had casing trouble and is valueless as to showing the possibilities of production from deeper sands.

The original rock pressure in the 2,400-foot sand was about 950 pounds, but it has declined to about 100 pounds at the present time. The pressures in the shallower sands were less, and vary greatly in different locations.

No oil showings have been found above the 2,400-foot horizon. Deeper drilling may develop an oil accumulation, but nothing so far found has led one to suspect the presence of oil.

The future life of the field as outlined will probably be short. The gas pressure on all the sands has decreased materially and salt water is encroaching rapidly, and has already killed a number of the wells. With the wells drilling at present it is a question whether or not they will produce enough gas to pay out.

White Point

Development in the White Point area dates back to 1904, when Randolph Robertson drilled the first well to a depth of about 450 feet. Several wells were drilled during the next two years, two of which were lost through blowouts. Development then rested until 1915, when the Gulf Oil Corp. took leases and began a drilling campaign. Several other companies and individuals took leases and drilled wells also, but the early story of the field is one of numerous blowouts and craters. This activity almost entirely ceased in 1919, and the Gulf company gave up most of its leases. Since that time little had been done in a systematic way to develop the field until W. L. Pearson and associates became interested in 1926. Mr. Pearson has drilled four wells in a north-and-south line and has made gas producers out of all of them. They are at present either closed in or are furnishing the small amount of gas necessary for the two small towns of Taft and Sinton.

The White Point Field is located on the highest point of land on the north side of Nueces Bay. Undoubtedly this topographic high reflects somewhat the underground structure, but does not outline the field. Dry holes have been drilled on the high ground and blowouts have occurred in wells located on the tide

As to the future, no data are available on which to base a guess, as the new wells have been pulled on very slightly.

Saxet Gas Field

The Saxet gas field is located on the south shore of Nueces Bay, due south of the White Point Field, and about 4 miles from it. Some think that there is a connection between these two fields, but we have no data to prove or disprove this theory.

Development here began in 1922, and the first well was brought in late in that year. Four other wells have been drilled, two of which are producers. One was junked and abandoned and one was a dry hole.

No indications of surface structure are present, and not enough drilling has been done to give an idea of subsurface conditions. The reservoir rock seems to be a flat lyin sand and sandy shale containing both gas and salt water. All the wells so far brought in have produced some water.

The field has been furnishing gas to Corpus Christi and Robstown for the past three years, and the wells seem to be long lived. An estimate of future production must depend on the future delineations of the producing area.

Lucas

The first well in this field was drilled by Houston Oil Co. of Texas. It was started in December, 1922, and blew out and was abandoned early in 1923, at a depth of 876 feet. This was simply a gas pocket, as no gas has been found at that depth in the subsequent drilling. The field is located in the extreme southern part of Live Oak County, and along the Nueces River.

The sands which are producing gas at the present time are found in the lower Frio of upper Fayette beds of Eocene age, and from a depth of 1,750 to 2,300 feet.

The surface indication of subsurface structure is the presence of a large inlier of Oakville sand which has been thrust up through the overlying Lapara, Lagarto and Reynosa beds. However, the outlines of this outlier of Oakville sand do not delimit the field, as dry holes have been drilled on it.

The structure is an anticline running northeast and southwest, with a break near the south end between two areas of production. This is probably due to a sand condition as the producing sands are absent in this barren area.

There is no indication of faulting, either on the surface or as determined from the drilling. There are indications of tension cracks to a depth of 700 feet, but there seems to be no displacement.

The sands seem to be lenticular and fine grained, and do not give up the gas rapidly, but wells have been brought in with a gauged capacity as high as 50,000,000 cubic feet per day. Some of the sands have a large amount of volcanic ash.

Only one well has been drilled below 3,000 feet. It was drilled to a depth of 4,130 feet, the bottom 1,300 feet being wholly in shales. A little gypsum was found in the bottom 300 feet.

The gas pressure on the first wells drilled was about 950 pounds per square inch, and wells recently completed have nearly the same pressure.

The wells have been widely spaced and about 6,000 acres have been proven productive. Certain wells have been producing for 18 months and have produced over 1,000,000,000 feet, each, with a very small reduction in pressure. From this it can be assumed that the field will be long lived. As has been stated before, some of the sands give up the gas slowly, so it is possible to draw only a small percentage daily of the open flow capacity.

Three Rivers

As this field has become practically depleted, we will dwell on it very briefly.

The Three Rivers gas field is about 10 miles west of the town of Three Rivers, in central Live Oak County. The first drilling was done in 1920 by the Live Oak Basin Oil Co. Their first well was a gas well at 985 feet, with an estimated capacity of 30,000,000 feet, and 410 pounds pressure. Several more wells were drilled and a gas line was built to San Antonio, 70 miles distant.

Little is known of the structural conditions. There is some faulting in the field, but its relation to production is unknown. The producing horizon is sand and sandy shale—in some wells quite coarse and in others very fine.

The original pressure was about 400 pounds, which has steadily declined till some of the wells are entirely dead.

Unless other producing areas are found in the vicinity this field has very little value as a future supply.

Kingsville

The Kingsville Field is in Kleberg County, about 6 miles southwest of the town of Kingsville.

Early in the history of the development of the Gulf Coast attention was attracted to this area from the fact that no potable water could be found on it, while good artesian wells were common on the land surrounding it. But it was not until 1917, shortly after gas was found in a well drilled for water on the Rosse farm, that any attempt was made to drill for oil or gas. The first well was abandoned at 1,400 feet after having found a good showing of gas at that depth. The second well has a blowout at a depth of 2,143 feet, but was saved and has been producing gas almost continuously since. This is another field in which blowouts were the rule rather than the exception during its early development. In 1922, the Humble Oil & Refining Co. took over a large tract of acreage and has brought in several oil wells in the eastern part of the field. There are also several gas wells interspersed through the oil wells, but the relation of the gas and oil to the structure is very little understood.

There are very few indications of surface structure, and the only point that has been proven as to subsurface structure is that there is a very steep dip to the northwest.

The productive sands seem to be very lenticular, but the zone in which they occur is continuous.

One well has been drilled by the Humble company below 5,000 feet, but its geological value is unknown outside that company.

Some of the wells have shown a gas pressure as high as 1,500 pounds, but most of the gas has been associated with oil or water, so the value of the

field from the standpoint of the production of gas still remains to be proved.

Cole-Bruni

The Cole-Bruni gas field is located along the line between Webb and Duval Counties, about 50 miles east of Laredo.

The first drilling was done by the Cole Petroleum Co., in 1922. The first three wells had several showings of gas, but were abandoned as failures, and it was not until their fourth well, drilled in 1924, was brought in, that the gas possibilities were known. This well blew in unexpectedly from a depth of 1,708 feet, ran wild, and finally caught fire. It burned about 40 days before the fire was extinguished and the well put under control.

There are no indications of surface structure, and the production of gas seems to depend more on sand conditions than on subsurface structure. There is a noticeable change in dip to the west of and parallel with the line of production, and the gas seems to lie in the area of steeper dip. There has been some attempt made to locate a fault along this line of change in dip, but the mass of evidence is against it.

The gas is found in rather coarse sands and sandy shales, and at one place on the eastern side of the field a little oil has been found.

The sands seem to be continuous from north to south, but change to shales to the west.

The gas pressure on the first wells brought in was about 525 pounds, and the pressure on the wells now being brought in is very little less.

Gas has ben developed over an area about 9 miles long by 2 miles wide, so the field gives promise of producing a very large amount of gas. About 4 miles to the west of the present field a well has recently been brought in from a depth of 2,300 feet, which gives promise of proving another area as productive, and in a deeper sand.

Carolina-Texas

The Carolina-Texas gas field is located in southwestern Webb County, about 40 miles northeast of Laredo.

The first well in this area was drilled in 1921 by the Carolina-Texas Oil & Gas Trust. This well was a small gas well at 1,300 feet, and was later drilled to 2,000 feet, where a much larger gas well was brought in. Since that time numerous gas wells have been brought in and the field fairly well outlined. This field presents the most clearly defined subsurface structure in the Laredo area. It seems to be an anticline with a fault on the west side. This fault has the down throw on the west. Several sands are productive between 1,300 and 3,200 feet, with the gas wells in the deepest sand showing a high gasoline content, and some wells producing a little high gravity oil.

There has not been enough gas taken from the field to form any definite estimate as to the life of the wells, but as the proven productive acreage is large it can be assumed that a large amount of gas will be produced from the various sands.

In the territory to the south and southwest of the Carolina-Texas Field and the Cole-Bruni Field there is a large area which has been developed primarily for oil, but in which there are small areas which are also productive of gas. These various small areas will in the aggregate eventually produce a large volume of gas.

Numerous Pipe Lines

There are numerous gas pipe lines drawing gas from the Southwest Texas are at the present time. The largest of these is the line of the Houston Pipe Line Co., with a daily capacity at present of 90,000,000 cubic feet. This line is connected with the Refugio Field, the Lucas Field, the Cole-Bruni Field and the Carolina-Texas Field. The next in point of capacity is the line of the Houston Gulf Gas Co., with a daily capacity of 50,000,000 cubic feet. This line is connected with the Refugio Field and contemplates building to the White Point Field in the near future. Next in point of capacity is the line of the Southern Gas Co., which is connected with the Three Rivers Field, the Cole-Bruni Field, the Carolina-Texas Field, and the field west of Mathis, in San Patricio County, and has a gathering line into the area southwest of the Cole-Bruni Field. The Border Gas Co. has gathering lines throughout the Laredo area, and furnishes gas to the town of Laredo and the various pumping plants along the Rio Grande. The city of Corpus Christi draws gas from the Saxet Field, as does the town of Robstown. Taft and Sinton draw from the White Point Field, and the town of Kingsville draws from the Kingsville Field.

A line from the Laredo district through the Rio Grande Valley to Brownsville is contemplated in the near future.

Conserving Minor Supplies of Gas

Companies Have Found It to Be Wise Policy to Protect All Shows of Oil or Gas to Prevent Waste

By Wallace B. Gribble
General Superintendent, Hope Natural Gas Co.

Before treating this subject and the method employed in the West Virginia fields, it is advisable that some explanation be made of the varying conditions that prevail in the different sections.

In the northern part of the state the deeper sands are the principal producing formations; the upper or shallower sands become less productive and are finally lost altogether; the shallower or minor sands of the northern sections become the predominating producing sands in the south and west. Keeping in mind that the formations are more or less irregular; a particular formation or sand may produce gas in one section, oil in another, water in another, or wholly barren in another; that any one or several formations may be productive of either oil, gas, or water, or all of them, in the same well. Therefore, no hard or fast rules can be laid down as to the proper method of handling these productions; each producing area and often individual wells must be treated separately and individually. In view of these conditions, only the more generally used methods will be discussed.

In conserving the minor supplies of gas and oil, applicable to the northern section where the sands are regular, there is very little water from the producing formation; gas has been taken care of by setting the different strings of casing at such points producing the gas between the casing, controlling the same by means of a stuffingbox casing head. During the process of drilling where the quantity justifies, it may be jetted into the boiler until the proper depth has been reached for the placing of the next string of casing, after which the casing head is installed and the gas confined and fed into the carrying pipe line. At the completion of drilling, this gas is then cared for in the regular manner as the gas produced from the predominating sand, that is, it may be shut in or marketed at will. In running the casing, it should be made absolutely free from leakage, as a protection against water leakage from without and gas leakage from within.

Packer Run on Casing

In the producing areas farther south, varying methods are necessary. If the quantity of gas justifies, a packer is run on a string of casing as soon as practicable after the gas is found, sealing the gas behind the casing until after the drilling is completed, then the casing is perforated on the same level as the gas pay and then produced in the regular way. This method is used when it is necessary to protect the gas from water which may be found above or where there is no pipe line system available into which the gas may feed. Often water is found above or below the gas pay. Where the water is above, an anchor packer is set above the gas, and the gas brought into the casing by means of a perforation. When the water is below the gas, and the upper hole free of water, a bottom hole packer may be run on the bottom of the casing string, an anchor packer above the water, which seals the water back of the casing, and the gas is produced between the casing. If water is found both above and below the gas, three packers may be set, two below the gas as above to seal the lower water, and one above the gas to seal the water above the gas sand. The gas is brought into the casing through a perforation.

Small quantities of oil are more difficult to produce than gas on account of its being necessary to lift it to the top of the hole by pumping. This is often accomplished by setting packers for protection similar to the method used in gas wells, using a perforation in the casing and allowing the oil to find its way into the well and is produced along with the oil from the deeper sand. Where oil is found in an upper sand, and gas in the deep sand, the oil and gas are sometimes separated by the use of two strings of tubing. A string of tubing is run on a packer and set below the oil pay; the gas produced through this tubing. A second string of tubing, equipped with standard pumping outfit, is then hung alongside of the first and the oil produced by pumping. The size of the tubing used must be governed by the size of the inside string of casing; this method is not practical where the well is less than 6 inches in diameter.

Often small quantities of gas or oil are discovered not of sufficient quantity to justify any method of producing. It is a wise policy to save or protect all shows of gas or oil to prevent waste or water invasion. These minor quantities are protected either by casing of mudding. Later it may be advisable to shoot and again test before final abandonment of the well, after the lower sands have become nonproductive.

Protection from Water

The protection of gas wells from water invasion, like conserving minor gas and oil supplies, is one in which local conditions, and more especally the individual well must be considered. Water in gas wells is usually from one of three sources, directly from the gas producing sand which is usually salt water; condensed from the gas while it is being produced, condensing on the inside of the casing or tubing and finding its way back to the bottom of the well, this water being fresh; or from defective, leaking casing, tubing or packers, and which may be either salt or fresh.

Sands which carry large quantities of water along with the gas are best handled and the largest amount of gas produced by holding a reasonable pressure, depending on the original rock pressure on the well when new, while it is producing. When too low a pressure is maintained, the water has a tendency to flow rapidly towards the well pocketing the gas and cutting off the gas flow. Wells making large quantities of water from the gas producing sand may be tubed and pumped. Wells making only small quantities, either from the sand, by condensation, or seepage, may be bailed, either by stationary or portable bailing machines, depending on the quantity of water, amount of pocket or other individual conditions.

It is impracticable to pump a gas well making only a small quantity of water, due to the high initial cost of installation, and the difficulty in keeping the well in pumping condition, making the cost of operation prohibitive for the average well.

Care in Plugging

Careful attention must be given to the plugging of wells at abandonment to prevent flooding of the sands from this source. It is good practice to fill the pay sand with clay before setting plugs above the sand, as this forms an effective seal against the downward flow of water should the plug in any way prove defective. All producing formations should be treated in this manner and all plugs protected by placing a quantity of clay or neat cement on top of the plug.

Water, which finds its way into the well through defective casing, tubing, or packers, in sufficient quantities to interfere with production, is taken care of in various ways. If the tubing or tubing packer fails, it is usually necessary to pull and rerun the tubing, setting a new packer, although in many cases, the packer has been effectively sealed with clay or by the use of wheat or corn placed in the well around the tubing and allowed to settle on the packer, serving the same purpose as the seed bag of pioneer days. Casing leaks or seepage around the packers through the formations in which they are set is often effectively sealed by mudding.

Some of the operators are now drilling their wells into the pay sand in a reduced hole, that is, after the inside string of casing has been run, and in a solid formation above the pay sand, the hole is reduced, leaving a shoulder on which to set an additional string of casing in case the inside string becomes defective. This eliminates the use of wall packers, which are necessary when the smaller casing is placed in the regular size hole, and gives a better chance for setting tubing packers, which in the latter case must be special packers made to set in a larger size hole than the casing through which they are run.

Pocket Below Pay Sand

If water is not found immediately under the gas pay, the hole is drilled to a sufficient depth below the gas pay to form a reservoir or pocket to hold the accumulation of fluid. If the well is tubed, a perforation should be placed in the tubing near the bottom and another directly in the gas pay. This permits of the emptying of the pocket to the bottom, while the perforation in the gas pay allows a free flow of gas until the water fills the pocket to a point when it becomes necessary to bail or pump off the water. The depth of this reservoir is usually about 35 or 40 feet below the pay sand. This pocket permits cleaning out the well after shooting without making it necessary to run the jars below the shot hole, with subsequent danger of sand from the effects of the shot clogging and locking the jars.

Other than the preventative and corrective measures mentioned above, which should also include proper attention to and correct installation of casing and tubing in the drilling of the well, our most effective weapon in the protection of wells is undoubtedly the bailing machine, a light portable affair which can be moved quickly and at reasonable cost from one well to another. If it is necessary to bail a well more than five or six times per year, it is advisable, and more economical, to install a bailing machine permanently at the well, saving the moving expenses, also being immediately available when the well needs attention. When wells are given proper attention the water can be removed very quickly down to the upper perforation by swabbing, it being necessary to bail only that held in the pocket or reservoir below, or if the well has a fair volume of gas it can all be removed with the swab.

Dependable Natural Gas Service

for

Domestic, Industrial and Oil Field Requirements

A gathering, transporting and distributing system comprising approximately 2,000 miles of pipe lines taking gas from three dozen Oklahoma fields and serving more than 40 thriving cities and towns in Oklahoma, gives the greatest possible assurance of dependable natural gas service.

The satisfactory fulfillment of your fuel needs is the first consideration of every member of the Oklahoma Natural organization.

"If It's Done With Heat, You Can Do It Better With Gas"

OKLAHOMA NATURAL GAS CORPORATION
TULSA, OKLAHOMA

Our Motto: *"100% Service and Courteous Treatment to All"*

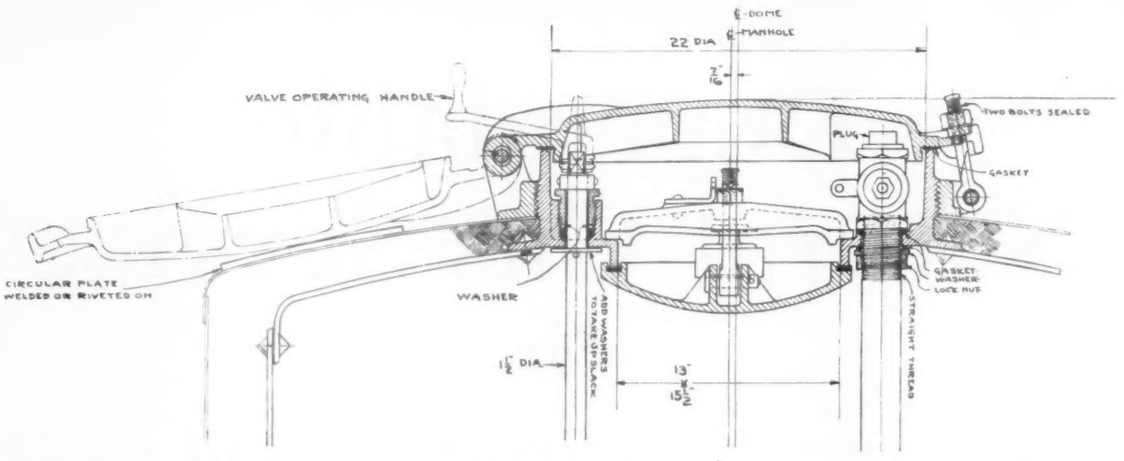


FIGURE 1.

New Vapor-Saving Devices for Class IV Tank Cars

The above drawing shows a new dome cover arrangement for Class IV Tank Cars, which, while retaining the present type of outer dome cover, introduces a new internal cover and other improvements with the following advantages:

Permits loading and unloading of natural gasoline without waste of wet gases, effecting a saving of several hundreds of gallons per car.

By eliminating waste gases, introduces a new factor of safety in the handling of this fluid.

Permits gauging contents of the tank without removing internal dome cover, by means of a new step gauge and two heavy plate glass peep holes in the internal cover.

Permits sampling of the liquid without removing dome cover.

The hinged internal dome cover can be dropped down to allow easy access to the inside of the tank.

The outer dome cover is gas-tight and provided with a special arrangement such that, if leakage should occur through the internal cover (which is practically impossible), the outer cover could not be opened and would provide an additional safeguard. In other words, all of these new devices are extra factors of safety, as the outer cover alone is equal in strength to the present standard dome cover.

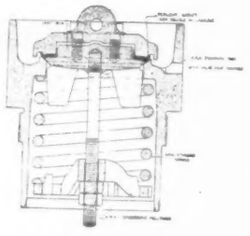


FIGURE 2.

Figure 2 shows a new safety valve, with patented resilient gasket, recently approved by the A. R. A. Tank Car Committee. While not a radical departure in general design from the type of safety valve now in use, the new arrangement has the advantage of preventing any escape of gases at pressures less than 25 pounds.

Seventy new Class IV cars with these new vapor-saving devices are now being built by us. Complete information on request.

American Car and Foundry Company

New York	Chicago	St. Louis
30 Church Street	Railway Exchange Building	915 Olive Street

Natural Gas in Rocky Mountain Area

Occurrence in Colorado, Montana, New Mexico, Utah and Wyoming is described. Future expansion is expected.

By Wilson B. Emery
Geologist, The Ohio Oil Company

This report discusses the geology of natural gas in Montana, Wyoming, Colorado, Utah, and New Mexico. As the area included is so large, the fields so numerous, and the occurrence of natural gas so varied, it is manifestly impossible to give a detailed description of all the fields in a short paper. Consequently it is proposed to treat in the body of this paper the salient general features of the region while at the end of the report is summarized in tabular form pertinent information regarding active gas fields or areas that now appear prospectively valuable for gas. Plate I is an index map showing the location of the various fields. On it also are shown towns now supplied with natural gas, all other towns being omitted.

Several of the oil and gas companies operating in the Rocky Mountain district have given freely of their information in order that this report may be as complete as possible; and for this cooperation thanks are due especially to The Midwest Refining Company, the New York Oil Company, the Producers and Refiners Corporation, the Hard Rock Oil Company, the Marland Oil Company of Colorado, the Union Oil Company of California, and the Consolidated Royalty Company. The plates accompanying the report were prepared by Mrs. Arthur F. Lesley and the table showing gas field data was compiled by Robert G. Kurtz, both of The Ohio Oil Company.

Principal Features

The outstanding topographic feature of the area covered in this report is, of course, the series of rugged ranges composing the Rocky Mountains. But far more important to the gas industry is the plains area from which the mountains rise, for on these plains are situated the gas fields of the district as well as the markets for the gas. Though in many fields there is considerable relief, the topography is not such as to make operations unduly difficult nor is it such that the construction of carrier lines is hampered. As would be expected in so large an area, the surface elevation of the different fields varies greatly; for example, the Cabin Creek Field in Montana has a surface elevation of about 2,700 feet while the ground in the Baxter Basin Field in Wyoming ranges from 7,000 to 8,000 feet above sea level.

Not only do the fields differ greatly in surface elevation but, because of their extensive geographic distribution, there is also a wide variation in their temperature and weather conditions. Thus temperatures of 40 degrees or more below zero are not uncommon at Shelby and Havre, Mont., and winters are apt to be long, while on the contrary at Aztec, N. Mex., below zero temperatures are rare and in general severe winter weather is of short duration. Therefore, on account of temperatures involved, geographic location plays an important role not only in the hardships it may cause during the development of a field but also in determining the value of a domestic market for the production.

Distribution of Fields

The wide distribution of gas fields in the Rocky Mountain district has been suggested in the above paragraph. The fields are divided among the various states as follows:

Colorado	7
Montana	6
New Mexico	2
Utah	2
Wyoming	20

For the most part the fields in this region obtain their production from sands on well-closed anticlines or domes although some gas, as at Florence and Boulder, Colo., has been produced from shale in wells not on closed geologic structures. A somewhat unique occurrence for gas in such considerable amounts is that in the Kevin-Sunburst Field of northern Montana where, notwithstanding that the gas occurs on a well-closed dome, its accumulation seems to be due to the lenticularity of the reservoir sand rather than to the influence of structure.

Much of the gas in the Rocky Mountain region comes from rocks of Cretaceous age with important production also from the Jurassic. Two fields in northwestern Colorado obtain their yield from sands in the Eocene (Tertiary) but gas from reservoir rocks of this age has not yet been found elsewhere in the western states. In the Artesia Field of southeastern New Mexico, and really outside the Rocky Mountain region proper, small amounts of gas have been encountered in the Permian.

Rock pressures naturally differ greatly but in general are about normal for the depths to the productive horizon in the various fields. There is also a wide range in the initial production from wells of the different fields. Large volumes of gas per day are common, one might almost say typical, many wells showing initial production of 20,000,000 cubic feet or more, whereas wells with initial yields as high as 80,000,000 cubic feet per day are not unusual.

History

Natural gas seeps, though not numerous in the Rocky Mountain region, were nevertheless probably known to the pioneers who often were keen observers of natural phenomena. It is, however, difficult to ascertain just when gas was first utilized in the West. Probably one of its earliest commercial uses was that recorded in 1886, by the United States Geological Survey in its annual volume, Mineral Resources of the United States, in which report mention is made of gas being burned as fuel under evaporating vats connected with the manufacture of salt near Salt Lake City. Such use apparently continued until 1898 when it was finally abandoned. From that time sporadic attempts, with but indifferent success, have been made to develop gas along the shores of Great Salt Lake, but really it was not until 1924, when gas was discovered at Cisco, that Utah assumed importance as a gas producer. The following year gas in large amount was discovered at Ashley Valley, but there have been no important discoveries in the state since then. At present natural gas is not piped to any of the towns in the state, and its only commercial use is in the carbon black plant at Cisco.

Use in Colorado

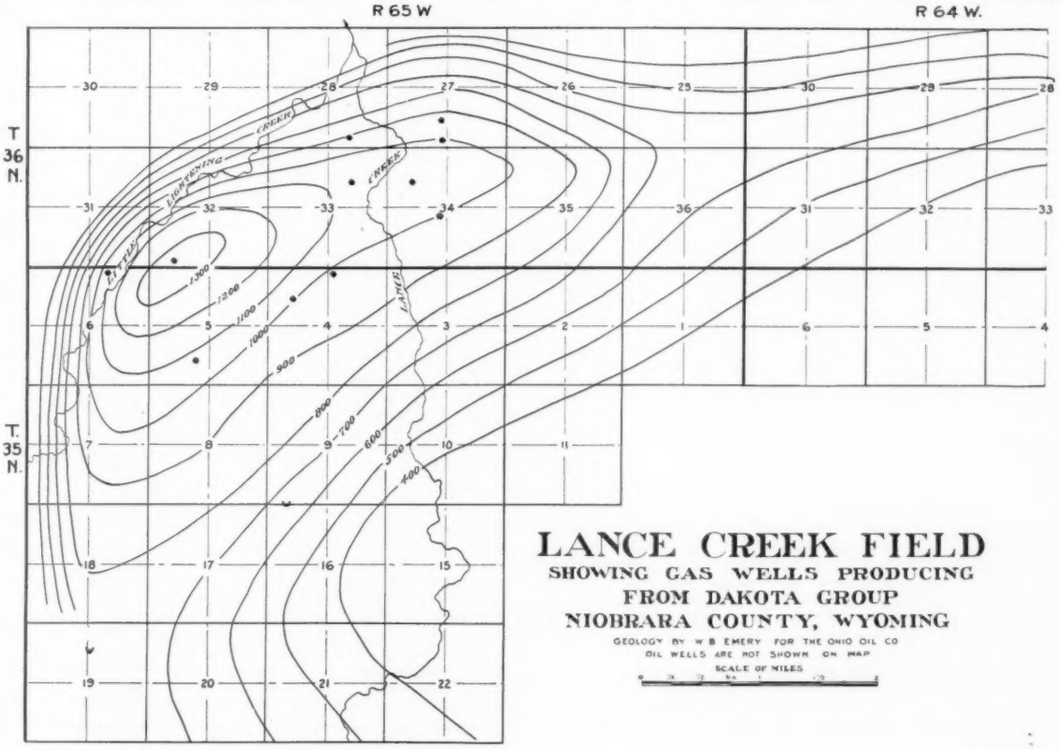
Colorado seems to have witnessed, next to Utah, the first use of natural gas in the West, for when gas was discovered near Florence in 1887 it was for a short time used to illuminate the town, according to the United States Geological Survey. Subsequently gas from oil wells in the Florence Field was consumed in a small way domestically and this for many years constituted the only use of natural gas in the state. In 1903 the discovery of a gas well east of Boulder resulted in the piping of the town and natural gas accordingly assumed a much more important role in the industry of the state than it had theretofore. For a number of years this well supplied Boulder but finally in 1914 its complete failure necessitated the use of artificial gas. From then until the discovery of gas on the Wellington Dome in 1923, the industry was practically dormant. The new discovery, however, gave a decided impetus to prospecting and also resulted in the introduction of gas into Fort Collins as well as Cheyenne, Wyo., in 1926. Since the Wellington discovery several important gas areas have been opened up by drilling in the northwestern part of the State, but to date Wellington is the only field being used commercially.

Gas in Wyoming

In 1903, the same year gas was discovered at Boulder, Colo., two gas wells were drilled in Brenning Basin near Douglas, Wyo., and with the completion of other wells the following year serious consideration was given to the piping of Douglas for gas. These plans, however, were never realized so that the first utilization of natural gas for domestic consumption in any town in Wyoming was in 1909 when this fuel was introduced into Basin and Greybull. Two years later Byron was furnished natural gas from the Garland anticline and for several years these three were the only towns so supplied in Wyoming. However, gas fields continued to be discovered from time to time in Bighorn Basin as well as in central Wyoming and south central Wyoming, and in the fall of 1920 gas was delivered to Casper where it is used for both domestic and industrial purposes. Subsequently gas has been introduced into several towns in the Bighorn Basin and also into Rawlins, Parco, and Rock Springs in southern Wyoming. Cheyenne now receives gas from the Wellington Field in Colorado, previously mentioned.

Montana Development

Development of the natural gas industry in Montana followed shortly after that in Wyoming and the year 1914 witnessed the discovery of gas on the Baker anticline near Glendive in the eastern part of the state and at Havre near the northern boundary of the state. The discovery in each locality was of such importance that plans for piping the nearby towns were taken under consideration, and upon the completion of other wells both Glendive and Havre were so piped and furnished with gas. About the same time gas was found near Baker and became available for domestic consumption there. The discovery of gas near Shelby in 1922 resulted in the introduction of gas there a short time later. In 1921, Billings was supplied with gas from the Elk Basin Field in Wyoming and since that time, use of this fuel


R 65 W
R 64 W.
T 36 N.
T. 35 N.
LANCE CREEK FIELD
SHOWING GAS WELLS PRODUCING
FROM DAKOTA GROUP
NIOBRARA COUNTY, WYOMING
GEOLOGY BY W B EMERY FOR THE OHIO OIL CO
OIL WELLS ARE NOT SHOWN ON MAP
SCALE OF MILES

SUMMARY OF GAS FIELD D

Name of Field—	Location—	No. of Prod. Wells	Name of Prod. Horizon	Depth of Prod. Horizon	Productive Acreage	Initial Prod. of Wells	Initial Rock Pressure	Present Rock Pressure	Name of Company Owning Production	Nature of Market	Name of Market
COLORADO:											
Carbonera	T 6-7-8S R 102-103-104w	4	Dakota	3,100-3,300	....	50,000,000	800	800	Sun Oil Co. Gypsy Oil Co.	.....	.....
Garmesa	T 8S R 104w	..	Dakota	3,100-3,300	480	50,000,000	800	800	Sun Oil Co. Gypsy Oil Co.	.....	.....
Hiawatha	T 12n R 99-100w	1	Tertiary	2,215	....	25,000,000	840	.....	Morris et al	.....	.....
Rangeley	T 1-2n R 102-103w	2	Dakota	3,000	5,500	75,000,000	1,275	1,275	Midwest Ref. Co. Texas Prod. Co.	.....	.....
Tornburg	T 3n R 91w	3	Dakota	2,000	500	40,000,000	800	800	Marland Oil Co.	.....	.....
Wellington	T 9-10n R 68-69w	3	Dakota	4,200	430	52,000,000	1,310	1,275	Union Oil Co.	Domestic	Ft. Collins, Colo. & Cheyenne, Wyo.
White River	T 1-2n R 96-97n	..	Wasatch	500- 760	1,700	.....	.....	.....	.....	.....	.....
MONTANA:											
Baker	T 7n R 59E	8	Sand in Pierre Shale	800	640	6,000,000	180	58	Montana Pet. Co. & Absaroka Oil Dev. Co.	Domestic & Industrial	Baker
Bowes	T 31n R 15E	4	Eagle & Virgelle	800-3,150	5,000	10,000,000	285	285	Hardrock Oil Co.	Domestic & Industrial	Havre and Chinook
Cabin Creek	T 10n R 58E	2	Sand in Pierre Shale	795-1,000	2,500	.....	.....	.....	Minnesota Northern Power Co.	Domestic & Industrial	Glendive
Gas City Pool (Glendive)	T 14n R 55E	4	Sand in Pierre Shale	800-1,880	800	3,500,000	.....	220-280	Eastern Montana Oil & Gas Co.	Domestic & Industrial	Glendive
Kevin-Sunburst	T 31-32-33n R 1w	5	Sunburst	1,200	1,920	3,000,000	300	300	Ohio Oil Co. Sunburst Oil Co. Northern Star and others	Domestic & Industrial	Shelby
Lake Basin	T 1n R 21E	12	Eagle & Frontier	1,300-3,000	2,560	1,000,000 to 30,000,000	300-900	.....	Record Oil Co. Delmar Co.	Industrial	.....
NEW MEXICO:											
Aztec	T 30n R 11w	2	Farmington Sand	1,000	40	2,000,000	.....	.....	Aztec Oil & Gas Co.	Domestic	Aztec
Ute Dome	T 32n R 14w	2	Dakota	2,400	640	10,000,000 to 37,000,000	.....	.....	Midwest Ref. Co. & Producers & Ref. Corp.	.....	.....
UTAH:											
Ashley Valley	T 6n R 22E	1	Dakota	1,695	....	20,000,000	.....	.....	Utah Oil Ref. Co.	.....	.....
Cisco	T 21s R 22-23E	4	Dakota	1,950	1,600	100,000,000	.....	170	Crystal Carbon Black Co.	Industrial	.....
WYOMING:											
Baxter Basin	T 16-17-18-19n R 103-104w	10	Dakota	1,800-3,000	2,000	1,000,000 to 65,000,000	780-875	.....	Ohio Oil Co. Midwest Ref. Co. Producers & Ref. Corp.	Domestic & Industrial	Rock Springs
Big Sand Draw	T 32-33n R 95w	6	Frontier	2,300-3,300	1,560	40,000,000 to 60,000,000	1,100	1,050	Prod. & Ref. Corp.	Domestic & Industrial	Casper, Riverton, Glenrock, Lander
Billy Creek	T 48n R 82w	6	Wall Creek	3,082-3,458	1,280	40,000,000 to 60,000,000	1,150	.....	Con. Roy. Oil Co. Western Exp. Carter Oil Co.	.....	.....
Boone Dome	T 35n R 85-86w	5	Wall Creek	1,500-2,200	160	1,000,000 to 2,000,000	550-760	250-400	New York Oil Co.	Domestic & Industrial	Casper
Buffalo Basin	T 47-48n R 99-100w	8	Frontier	1,700-1,850	2,000	60,000,000	600	400	Ohio Oil Co. Midwest Ref. Co.	Domestic & Industrial	Worland Basin Greybull
Elk Basin	T 57-58n R 99-100w T 98-R23E	3	Greybull	2,300	1,200	75,000,000	Estm. 1,130	830	Ohio Oil Co. Midwest Ref. Co.	Domestic	Billings, Laurel, Bridger and others
Enos Creek	T 45-46n R 99-100w	1	Frontier	4,000	820	40,000,000	.....	750	Ohio Oil Co. & Midwest Ref. Co.	.....	.....
Garland Anticline	T 55-56n R 97-98w	9	Lakota	1,500-1,900	1,920	12,000,000 to 30,000,000	350-675	.....	Ohio Oil Co. Cross Gas Co.	Domestic & Industrial	Powell Lovell Cowley
Golden Eagle	T 45r R 97w	2	Eagle	2,270-2,980	200	80,000,000	1,200	.....	.....	.....	.....
Hatfield	T 19-20n R 88w	2	Dakota	3,965	350	22,000,000	1,708	800	Prod. & Ref. Corp.	Domestic & Industrial	Parco
Hilden Dome	T 47-48n R 90-91w	5	Frontier	1,000-1,500	640	4,000,000 to 28,000,000	725	112	Ohio Oil Co.	Domestic & Industrial	Greybull Basin & Manderson
Lance Creek	T 35-36n R 65w	11	Dakota	3,100-3,500	2,100	20,000,000 to 30,000,000	1,200	.....	Union Oil Co. West. States Oil Co. Continental Oil Co. Ohio Oil Co.	Industrial	.....
Little Grass Creek	T 46n R 99w	1	Frontier	2,665-2,900	160	12,000,000 to 30,000,000	790	790	Thermopolis Gas Co.	Domestic	Thermopolis
Little Pole Cat	T 57n R 98w	4	Frontier	4,400	2,000	2,500,000 to 6,000,000	.....	400-450	Danker et al. Transcontinental Oil Co.	.....	.....
Mahoney Dome	T 25-26n R 87-88w	18	Dakota & Sundance	2,540-3,100	4,100	18,000,000 to 44,000,000	1,085	1,015	Ohio Oil Co. Prod. & Ref. Co. Prairie Oil & Gas Co.	Domestic & Industrial	Casper Rawlins Parco
Oregon Basin	T 50-51n R 100w	4	Greybull	1,300-1,800	1,200	25,000,000 to 30,000,000	700	600	Ohio Oil Co. & Enalpac Oil Co.	Domestic	Cody
Poison Spider or South Casper Creek	T 33-34n R 83w	32	Sundance	1,500	320	30,000,000	500	30-50	New York Oil Co. Fargo Western Oil Co.	.....	.....
Salt Creek	T 39-40n R 78-79w	..	2nd Wall Creek	1,000-2,500	....	.....	.....	.....	.....	.....	.....
Teapot Dome	T 38-39n R 78w	55	2nd Wall Creek	1,800	3,000	.....	930-1,020	350-550	Naval Res. No. 3	Domestic & Industrial	Casper
Wertz	T 26n R 89w	6	Dakota	3,400-3,965	325	43,000,000	1,800	1,575	Prod. & Ref. Corp.	Industrial	Midwest Ref. Co.

has been made available to a number of towns between Elk Basin and Billings. The gas in the Lake Basin Field west of Billings is used industrially for the manufacture of carbon black but the plant is at present temporarily shut down.

New Mexico

In New Mexico gas was discovered on Ute Dome in San Juan County in 1921 and subsequent drilling developed large production which is not as yet being utilized. In the opposite corner of the state gas in small amount has been found in the Artesia district but the volume is not large enough to result in its use for domestic consumption except locally in the field. At present the only town being heated by natural gas is Aztec in San Juan County where the close proximity of wells to a market has made possible the use of the small amount of gas produced.

Stratigraphic Occurrence

It is to be expected that in a region so extensive as that here discussed there should be from place to place a considerable difference in the lithologic character and thickness of rocks of the same age. The accompanying table shows the stratigraphic sequence from the Mississippian to Recent at several localities in the area so chosen as to give a general idea as to character of the section in all parts of the Rocky Mountain region. It is not intended as a correlation table, although the similarity of names and the succession will suggest the approximate equivalency of certain formations to one familiar with stratigraphy. On Plate II the Jurassic and Cretaceous rocks are shown graphically as these rocks yield all the natural gas now used in the Rocky Mountain region and so are of most interest to the reader. It is naturally impossible in a short space to discuss fully the stratigraphy of this territory and accordingly only its broader features will be discussed below, especial mention being made of the type of rocks in each age, their origin and relation to natural gas occurrences. The reader is referred to the numerous reports of the United States Geological Survey, to the reports of the different state surveys, and to papers in geologic periodicals, for authentic detailed descriptions of the rocks in any particular fields where he may be interested.

Carboniferous

Throughout most of the region all the divisions of the Carboniferous, beginning with the Mississippian at the base and passing up through the Pennsylvanian and Permian, are represented by moderately thick sections. However, a noteworthy exception to this generalization is the absence of both the Pennsylvanian and Permain in northern Montana.

In Wyoming and Montana the lowest rocks of the Carboniferous are hard gray limestones of marine origin called the Madison limestone. This limestone is of Mississippian age. It ranges in thickness from less than 200 feet in the Lost Soldier region near Rawlins, Wyo., to

OF ROCKY MOUNTAIN AREA

Where Gas Used as Fuel — Line Size of Line	Line Owned By	Gas Marketed By	Gasoline Plants — Plant Owned By	Gasoline Plants — Capacity of Plant	Carbon Black Plants — Plant Owned By	Carbon Black Plants — Capacity of Plant	REMARKS
.....	.....	.....	.....	.....	.....	.....	Wells shut in.
.....	.....	.....	.....	.....	.....	.....	Wells shut in.
.....	.....	.....	.....	.....	.....	.....	Shut in; expect more drilling in 1927 to prove area.
.....	.....	.....	.....	.....	.....	.....	Wells shut in.
.....	.....	.....	.....	.....	.....	.....	Wells shut in.
8	Wyoming & Colorado Gas Co.	Public Service Co.	.....	.....	.....	.....	
.....	.....	.....	.....	.....	.....	.....	
3-4	Montana Pet. Co.	Montana Pet. Co.	.....	.....	Gas Products Co.	4,000,000	
6	Montana Gas Corp.	Havre Gas Co. & Chinook Gas Co.	.....	.....	.....	.....	Havre anticline formerly supplied town of Havre.
.....	.....	.....	.....	.....	.....	.....	
4	.....	.....	.....	.....	.....	.....	
6-4	Treasure State Pipe Line Co. & Ohio Oil Co.	Consumers Gas Co.	.....	.....	.....	.....	
.....	.....	.....	.....	.....	Crystal Carbon Co.	4,000,000	
.....	.....	.....	.....	.....	.....	.....	
.....	.....	.....	.....	.....	.....	.....	Shut in.
.....	.....	.....	.....	.....	.....	.....	Shut in.
.....	.....	.....	.....	.....	Crystal Carbon Blk.	.....	
6	Prod. & Ref. Corp.	Prod. & Ref. Corp.	.....	.....	.....	.....	Four productive areas on large anticlines.
10-12 6-4	New York Oil Co.	New York Oil Co.	New York Oil Co.	6,000,000	Columbian Carbon Co.	.....	
.....	.....	.....	.....	.....	.....	.....	Field shut in at present.
6	New York Oil Co.	.....	.....	.....	.....	.....	Line connected with 10 and 12-inch line at Poison Spider. Gas not being used in Casper.
14 12	Big Horn Gas Co.	Wyoming Gas Co.	.....	.....	.....	.....	Pipe line now under construction.
8-10	Gallatin Nat. Gas Co.	Billings Gas Co.	Midwest Ref. Co.	.....	.....	.....	Gas plant not operating.
.....	.....	.....	.....	.....	.....	.....	Not being used at present.
6 5⅝ 2	Rocky Mt. Gas Co. & Cross Gas Co.	.....	.....	.....	.....	.....	
4	.....	.....	.....	.....	.....	.....	Formerly supplied Thermopolis, Wyo., but now shut in.
6	Prod. & Ref. Corp.	.....	.....	.....	.....	.....	Porosity of sand 10 per cent. Field now shut in.
8	Midwest Wyo. Gas Co.	Midwest Wyo. Gas Co.	.....	.....	.....	.....	
.....	.....	.....	Ohio Oil Co.	8,000,000	J. N. Huber Co.	8,000,000	
3	Thermopolis Gas Co.	.....	.....	.....	.....	.....	
.....	.....	.....	.....	.....	.....	.....	Not being used at present.
10-12-14 6 8	Prod. & Ref. Corp. Midwest Ref. Co. Rocky Mt. Gas Co. Prairie O. & G. Co.	Prod. & Ref. Corp. Rocky Mt. Gas Co. Prairie O. & G. Co.	.....	.....	.....	.....	
4	Rocky Mt. Gas Co.	Rocky Mt. Gas Co.	.....	.....	.....	.....	
.....	.....	.....	.....	.....	.....	.....	Field not being produced now. Formerly supplied Casper, Wyo.
.....	.....	.....	Ohio Oil Co. Midwest Ref. Co. Carter Oil Co.	Total 65,000,000	.....	.....	Casinghead gas used for manufacturing gasoline.
8	Central Pipe Line & New York Oil Co.	New York Oil Co.	Standard Eng. Co.	Compression 1,500 gal. day 3,000 gal. day			Casinghead output of field 5,000,000 feet per day.
10-12-14	Prod. & Ref. Corp. Midwest Ref. Co.	Prod. & Ref. Corp.	.....	.....	.....	.....	Porosity 15 per cent.

nearly 2,000 feet in the Bighorn Basin area. In the Kevin-Sunburst area of northern Montana an important unconformity, marked by the complete absence of Pennsylvanian and Permain rocks, occurs between the Madison limestone and the overlying E lis formation (Jurassic) but this phenomenon is not present in other parts of the Rocky Mountain region. Whether or not the Madison was the source of the oil now found in the base of the Ellis is not definitely known, but the presence in a few deep wells of small amounts of oil in the Madison suggests that such may have been its source. If this should prove true, then there is some possibility that gas may also be found somewhere in northern Montana associated with the Madison, but in view of the drilling already done this possibility seems remote.

From central Montana southward the Pennsylvania is present and throughout Wyoming at least has been separated into two formations. Of these the lower, or Amsden, consists of 100 to 200 feet of red shales with minor layers of limestone followed upward by sandy limestones. The upper formation, called the Tensleep sandstone, consists of 30 to 300 feet of massive cross-bedded sandstones, in some localities alternating with beds of limestone. In areas where not divided into these formations, the sequence and character of the Pennsylvanian is nevertheless much the same as in Wyoming. Except as noted later, rocks of this age in the mountain region are mostly marine. Only very minor amounts of gas have as yet been found in the Pennsylvanian, but as these formation in Wyoming are prolifically oil bearing, it must be admitted that the Pennsylvanian is not wholly without prospects for gas though information now available is far from encouraging.

The Embar formation and its equivalents are assigned to the Permian. In Wyoming, where typically developed, it consists of 80 to 200 feet of light-colored marine limestones with minor amounts of sandstone. Chert is often present in the limestone. The formation yields oil abundantly at a number of places in Wyoming and therefore the possibility that somewhere gas may be found in it is not entirely lacking.

Pennsylvanian

The Pennsylvanian and Permian of the Rocky Mountain front in Colorado differs markedly in its lithology from that of the rest of the region described in this paper. It consists of 1,500 feet or more of red sandstones and shales, together with thick beds of arkose and is clearly of continental origin. This type of Pennsylvanian and Permian attains its greatest thickness in southern Colorado west of Trinidad where the section is said to measure over 10,000 feet. On account of its character and origin, it is not considered a favorable source for gas.

In southeastern Colorado and northeastern New Mexico, the Pennsylvanian again assumes a marine character, containing considerable amounts of lime-

A. H. WALKER & CO.

80 Wall Street, New York

ATLANTA BOSTON CHICAGO CLEVELAND SEATTLE
DENVER DETROIT MINNEAPOLIS DALLAS TULSA
PITTSBURGH SALT LAKE SAN FRANCISCO NEW ORLEANS LOS ANGELES

Valuations Appraisals Reports

Public Utility—Industrial

RATE CASES
SECURITY ISSUES

INCOME TAX
INSURANCE

PURCHASE OR SALE

Specialists in Natural Gas, Manufactured Gas, Oil, Water, Ice and Electric Utility Properties

EXPERTS IN FINDING VALUES!

RESULTS GUARANTEED

ECONOMIC SURVEYS of MUNICIPALITIES and COUNTIES
—INDUSTRIAL INVESTIGATIONS—

Address, Appraisals Division

A. H. WALKER & CO.

80 Wall St., New York

General Purchasing

For

Gas and Oil Companies, Banks, Public Utilities, Corporations, Railroads, Industries, Mines, Merchants, Engineers, Contractors, Architects, Municipalities, Institutions, Individuals.

GAS and ELECTRIC UTILITY EXAMINATION, PURCHASING, OPERATION and MANAGEMENT

stone and dark shales. Possibly gas or oil may be found here, but this remains to be proved by future drilling as the area has been but little tested as yet.

Southeastern New Mexico, though properly outside the Rocky Mountain province, deserves mention in passing as it is within the borders of one of the Rocky Mountain states. In the Artesia and Maljamar Pools of this part of New Mexico oil and minor amounts of gas have been found in beds of Permian age. Many of the holes start in the red beds of the Triassic, drill through red beds of Permian age and then through varying thicknesses of salt, in places over 1,000 feet of salt, into gray to light-colored limestone also of Permian age. It is in sandy lenses in this limestone, which attains a maximum thickness of about 1,100 feet, that production has been found. There is undoubtedly a source of hydrocarbons present in this series and therefore some little chance that larger production of gas may be discovered in it.

Triassic

Rocks of Triassic age are not present in northern Montana but from central Montana southward they are generally well developed. Wherever present in the Rocky Mountain region they are nonmarine in character. They consist for the most part of red shales and sandstone and because of their bright color, rocks of this age are among the most conspicuous of the entire area.

The Triassic ranges from 600 to 1,400 feet in thickness in Wyoming and northwestern Colorado and is still thicker in Utah and New Mexico. On account of its nonmarine origin it is regarded as unfavorable as a source of gas or oil and although black oil is occasionally found in rocks of this age in Wyoming, this oil is not considered indigenous. As yet gas has not been found in the Triassic of the area and it would seem that there is small likelihood of its discovery in economic amount.

Jurassic

Rocks of Jurassic age are present throughout the Rocky Mountain region except for a distance along the eastern front of the Rockies in Colorado. In Montana, Wyoming and northwestern Colorado the Jurassic is represented by the Ellis or Sundance formations composed of 150 to 300 feet of greenish to dark marine shales with interbedded limestones and sandstones. In southeastern Utah and adjacent parts of Colorado and New Mexico the Jurassic attains a greater thickness and consists almost wholly of red sandstones and shales of nonmarine origin, although in east central Utah a brief marine invasion is marked by a thin but very fossiliferous limestone.

Gas is found in the Sundance formation in central Wyoming and the present production below the Cretaceous in Mahoney Dome, south-central Wyoming, is also thought to come from the top sand of the Sundance. As oil has been found in the Jurassic at several localities, from northern Montana south into northwestern Colorado, and the presence of hydrocarbons in rocks of this age is thus demonstrated at widely separated localities in the northern part of the Rocky Mountain region, there is much reason to hope that future drilling may develop other gas pools in this zone in areas distant from the field now producing from it.

Lower Cretaceous

The lower Cretaceous of the mountain region consists of 400 to 900 feet of rocks, generally divided into two formations: the Morrison, or McElmo, at the base, and Cloverly, or equivalent formations, above. In northern Montana this division is not made, the entire series being grouped into a single unit called the Kootenai formation which there includes the productive Sunburst sand.

The rocks consist of very characteristic highly colored clay shales with interbedded layers of sandstone and minor amounts of conglomerate. In general, the sandstones are medium grained and gray to buff in color. They are more prominent in the upper part of the section than they are in the lower portion. Sandstones and conglomerate, as for example the Lakota at the base of the Cloverly which yields important production of gas, though occurring at about the same horizon in the upper part of the section at different localities, are not continuous and probably differ slightly in age from one place to another, due to the encroaching shore line conditions under which they were deposited. The lower Cretaceous is partly nonmarine and partly near-shore marine in origin.

Important yields of gas are obtained from the lower Cretaceous in the Rocky Mountain region; for example, at Kevin-Sunburst in northern Montana, on the Garland anticline in Wyoming, and also at Elk Basin, Wyoming, where part of the production comes from rocks of this age. Under suitable structural conditions these sands will probably be found productive in areas not yet tested. They are of great importance.

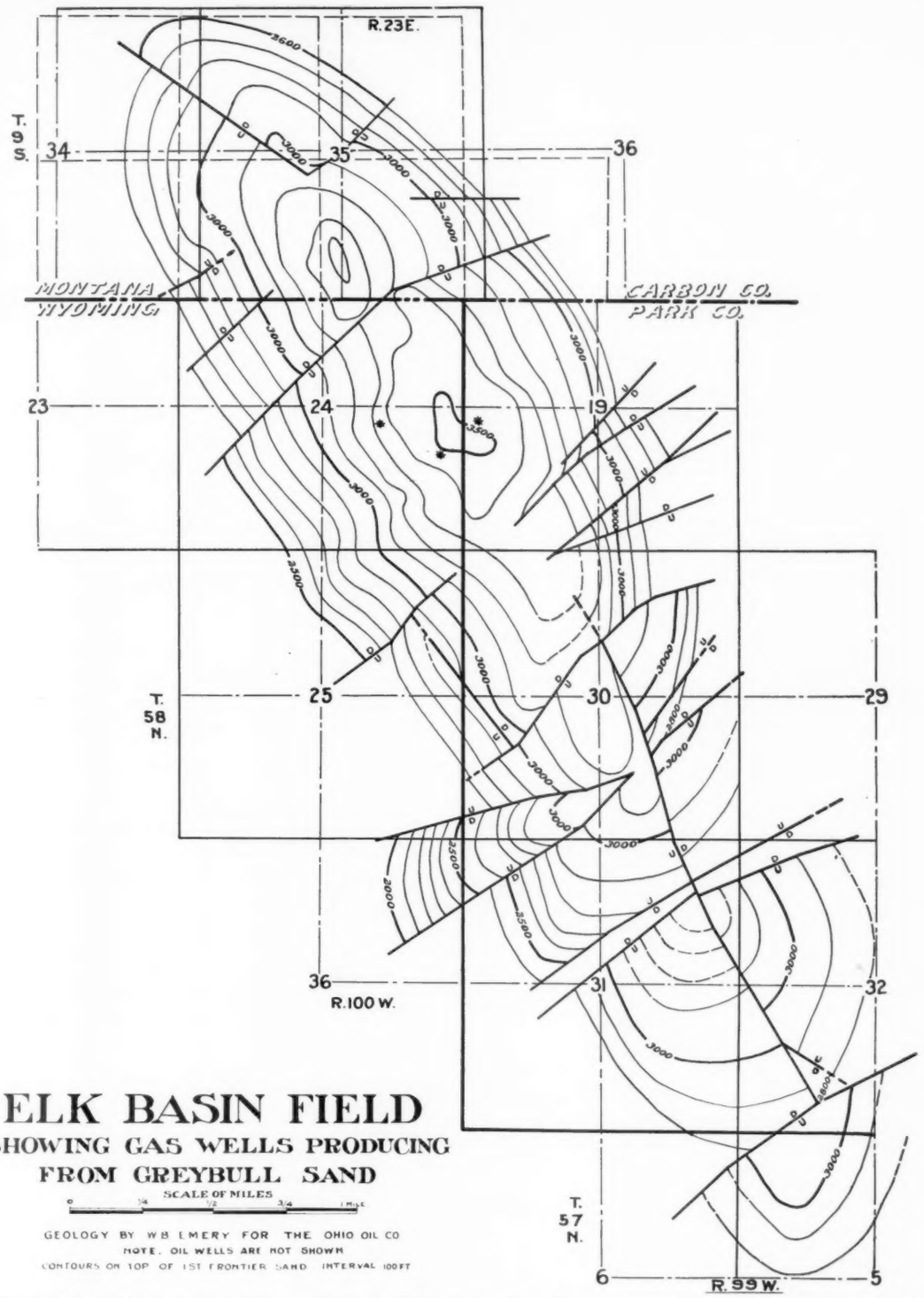
Upper Cretaceous

The upper Cretaceous is very completely represented in the Rocky Mountain area, ranging in thickness from a minimum of about 3,500 feet in central Montana to about 2 miles in central Wyoming. Except in northern Montana the base of the upper Cretaceous of the western states is marked by a series of sandstones and interbedded shales called the Dakota sandstone or Dakota Group. This series in Wyoming and Colorado ranges from 150 to 400 feet in thickness. At the base there is generally present a coarse, in places conglomeratic, sandstone; at the top is a medium to coarse grained sandstone, the Muddy sand of the Wyoming and northern Colorado fields. Between these sandstones and separated from them by shale, a third sandstone occurs over a large part of the region. The sandstones are gray to brown on the outcrop. The shale between the Muddy sandstone and that next below is gray; the shale below the intermediate sandstone member frequently is red or pink in color. Sands of this series yield abundant flows of natural gas, being productive at Elk Basin, Oregon Basin, Mahoney Dome and elsewhere in Wyoming; at Wellington, Rangeley, Garmesa and Thornburg Domes in Colorado; at Cisco Dome in Utah; and at Ute Dome, New Mexico.

The Dakota Group is followed upward by a thick series of gray shale of Colorado and Montana age. Because of their origin in seas evidently teeming with organism, these shales are thought to have been in large measure the source of the oil and gas now found in the Dakota sands as well as in the sands present in the lower part of the shale series itself.

Wyoming and Colorado

In Wyoming and Colorado the sands in this shale series are of such prominence that they are grouped together



into a separate formation called the Frontier. The top of this formation is marked by a buff to gray sandstone (the First Wall Creek or Torchlight sand of Wyoming) and near the base there is also a sandstone (Lower Wall Creek or Peay). Between these two horizons there is generally found one or more intermediate layers of sandstone separated by gray shales. Small, black, chert pebbles, because of the frequency of their occurrence in the sands, are regarded as characteristic of the formation. The Frontier as a whole is of near-shore origin. In Colorado and Wyoming it ranges in thickness from 250 to about 900 feet in thickness. From this region of its greatest development, this sandy series thins rapidly both to the north and south so that in northern New Mexico we find it represented by only a few feet of sandstone and what is thought to be its equivalent in northern Montana is but a few inches thick. Sands of the Frontier yield large volumes of gas at Buffalo Basin, Hidden Dome, Billy Creek, Boone Dome and elsewhere in Wyoming.

Above the Frontier formation the thick gray shales previously described are followed upward over much of the Rocky Mountain region by a series of heavy sandstones with minor amounts of interbedded shale, divided into several formations which, at least for purposes of this paper, may be conveniently grouped together as the Mesaverde. This group, ranging in thickness from less than 1,000 to nearly 5,000 feet, according to locality, is partly marine and partly non-marine in origin. One of its outstanding and characteristic features is its coal-bearing character. The Mesaverde group may be roughly divided into three parts: an upper and a lower portion, consisting principally of buff, medium grained sandstone, and a middle portion of shale and sandstones and generally coal-bearing. It is with the lower portion, or Eagle and Virgelle sandstones of Wyoming and Montana, that this report is principally concerned, for gas has been found in this part of the Mesaverde in northern Montana and again at Lake Basin near Billings, Montana. Production has also been obtained from the Eagle in the Golden Eagle Dome in Bighorn Basin, Wyoming. The Eagle and Virgelle sandstones, ranging in thickness from about 100 to 300 feet, are in part equivalent. These sandstones are soft and are composed of quartz grains of medium size. One the outcrop they are commonly buff in color. Because of their physical character they are excellent reservoir rocks and it is possible that future drilling may open up new gas pools in them.

Above the Mesaverde group there is present in the Upper Cretaceous over much of the area a series of marine shales similar lithologically to those underlying the Mesaverde. In some places this upper shale, variously called the Bearpaw or Lewis shale, marks the top of the upper Cretaceous but elsewhere, notably in New Mexico, and especially also in southern Wyoming and northwestern Colorado, there is present above it a coal-bearing series of rocks which in southern Wyoming attains a maximum thickness of over a mile. Owing to its largely non-marine character and consequent unlikeliness as a source of hydrocarbons, this part of the upper Cretaceous has not yet been much prospected in Wyoming and Colorado. In northwestern New Mexico, however, where it is not so unfavorable as a source of oil and gas, there has been considerable drilling in this part of the Upper Cretaceous and gas has been discovered in small amounts in the lenticular Farmington sand of the Kirtland formation. Gas from this sand supplies the town of Aztec with fuel. Recently gas has also been found in the Pictured Cliffs sandstone below the Fruitland formation in northern San Juan Basin.

Eocene

The rocks provisionally referred to as Eocene in the Rocky Mountain region are of nonmarine origin and gas has not yet been found in them.

The Eocene consists of an extremely variable series of rocks ranging in thickness to several thousand feet. To date gas has been found in the Wasatch formation of this age in two localities in northwestern Colorado. One of these is White River Dome on the stream of that name; the other is Hiawatha Dome on the Colorado-Wyoming line where gas has been discovered in the past few months. This discovery will no doubt result in further study and prospecting of the Wasatch at other localities. The formation has heretofore been considered as rather unfavorable as a source of hydrocarbons on account of its nonmarine character and but little attention has yet been given to its possibilities by the oil and gas industry.

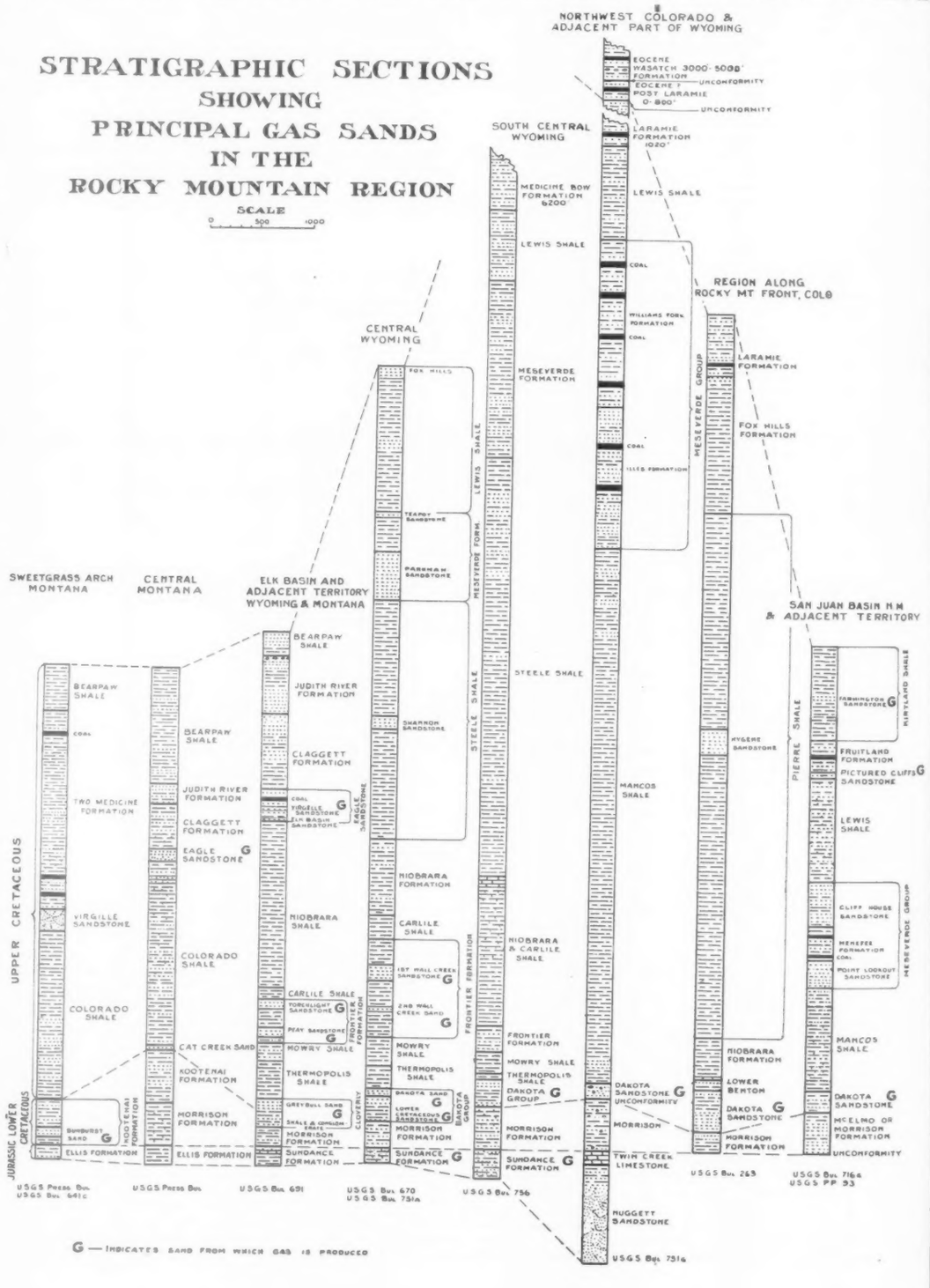
Geologic Structure

General Statement. The Rocky Mountain region is divided into a number of large structural depressions or geosynclines which in many cases correspond closely to the present day topographic basins. For example, the Bighorn Basin of Wyoming and San Juan Basin in New Mexico and Colorado are geosynclines whose geologic structure is reflected in their topography. Between the different geosynclines great uplifts of the earth's crust, closely coincident with our existing mountains, are present. Consequently these mountains and their accompanying basins, while primarily topographic features, nevertheless also indicate in a general way the major structural features of the western states.

A study of the geosynclines in the area reveals the fact that commonly around their margins the sedimentary rocks have been compressed into anticlines and synclines, while in the interior of the basins the sediments are nearly or quite undisturbed. It is on such marginal anticlines, often with several hundred feet of closure, that by far the greater number of gas fields in the Rocky Mountain region occur, and this is especially true of the pools in Wyoming and Colorado. One notable exception to this generality is the Baxter Basin Field located on the Rock Springs anticline in southern Wyoming, for this large uplift is not in any sense marginal, separating as it does the Green River from the Red Desert geosynclines. Another exception is the Kevin-Sunburst gas field of northern Montana.

Unfaulted Anticlines

The Lance Creek Field in eastern Wyoming (Plate III) has been chosen as illustrative of unfaulted anticlines on which gas has been found in the mountain states. The closure in this field, which is located on the crest of a large anticline, is about 500 feet but the fold plunges for many miles to the northeast beyond the closing contour. An inspection of the map will show that the structure is clearly defined, having well-proportioned flanks and a definite axis plunging gently from the crest. The north and northwest flank of the structure, dipping much more steeply than the south flank, gives the anticline a dis-



"Daddy's Thoughtfulness Protects Us Now"

Should you pass out today, could your widow say as much for you?

The widow in the above picture is clasping her son as she reads the provision her husband made for the comfort of his family against the time when they would be deprived of his protecting care.

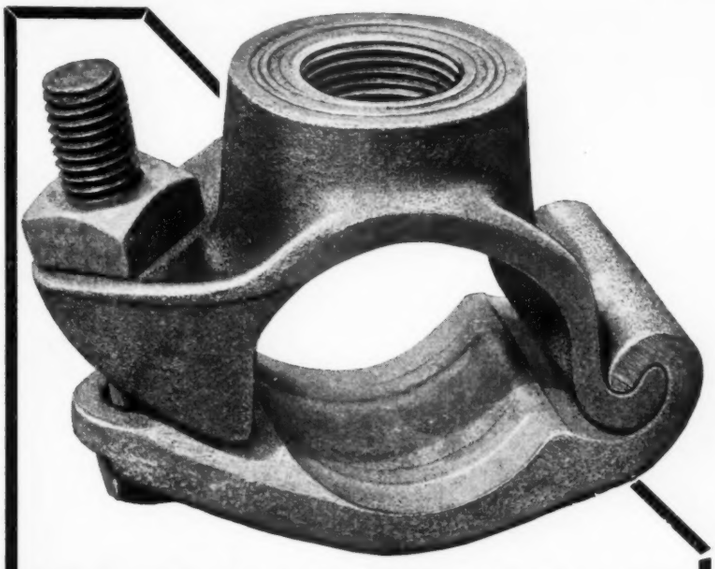
He made a will, by which was created a Trust, naming a responsible corporation as his Executor-Trustee, under the terms of which his family is relieved of the many and vexatious problems incident to the administration of an estate and making certain a regular income to provide for his loved ones.

While a man can leave no greater evidence of his love and thoughtfulness than is constituted by such a provision, he is derelict in his duty if he does less.

Our Trust Officer will be glad of an opportunity to explain how we can assist in making certain the care and attention your dependents should have after you are gone. Such an interview creates neither obligation nor expense.

The Central National Bank of Tulsa

Boston at Second



The New SKINNER Service Saddle

1. 50% of installation labor eliminated—the single nut to tighten is always on top. Almost no bell hole to dig.
2. Saddle much heavier—impossible to break. Good for pressure up to 500 lbs.
3. Larger bolt used.
4. Sliding skids on lower half produce an even draw and prevent tilting.
5. Note heavy hinge.
6. Malleable iron construction—permanent.

M. B. SKINNER CO.

558 Washington Blvd.—Chicago

Please send catalog with prices on the new Skinner Service Saddle—

Mail this today

.....

.....

.....

DEARBORN CHEMICAL COMPANY NO-OX-ID WRAPPER NEW YORK CHICAGO

NO-OX-ID

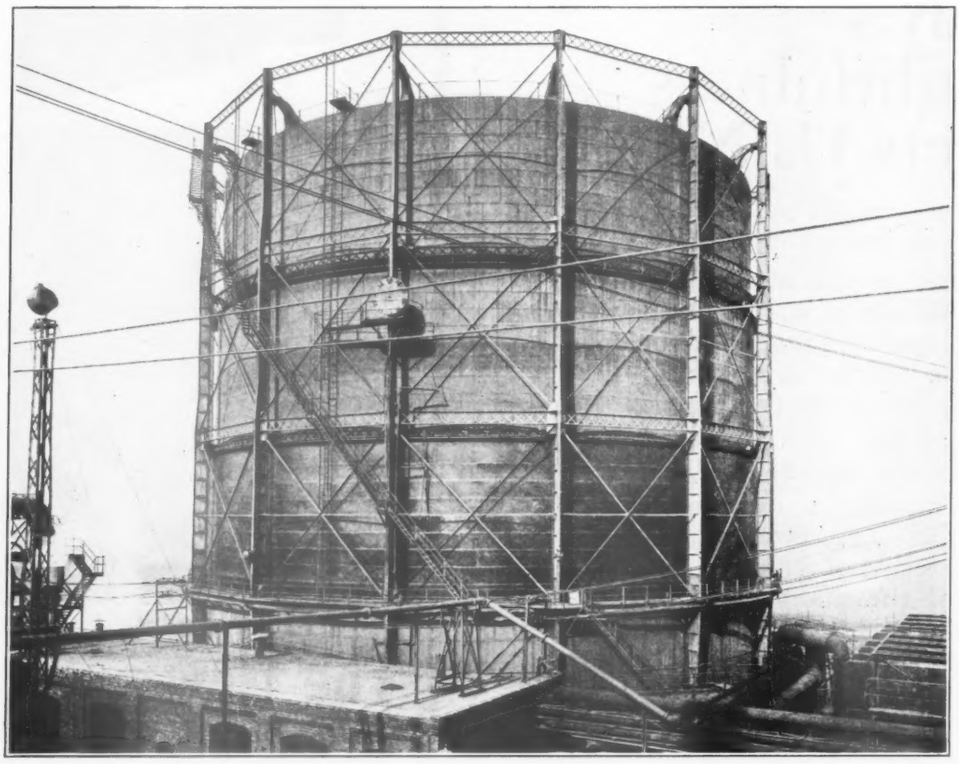
IRON + OX = RUST

TRADE MARK

The Original Rust Preventive

Preserves Gas Holders

Positively Stops All Corrosion that has Started and Prevents All Further Rusting



Saves Pipe Lines

At a Cost of a Small Per Cent the Life of You Properties Can Be Doubled —and More

Applying NO-OX-ID and NO-OX-IDized Wra

Left: Applying NO-OX-ID to kill all pitting and corrosion that has started.

Right: Showing NO-OX-ID-IZED Wrapper cut for application.

Chicago 310 So. Michigan Ave. Dearborn Ch

DEARBORN CHEMICAL COMPANY NO-OX-ID WRAPPER NEW YORK CHICAGO

DEARBORN CHEMICAL COMPANY NO-OX-ID-IZED WRAPPER NEW YORK CHICAGO

DEARBORN CHEMICAL COMPANY

NO-OX-ID-IZED WRAPPER

REG U.S. PAT OFF.

NEW YORK CHICAGO

The Spiral Wrap

Recommended on Pipe Sizes up to 12″

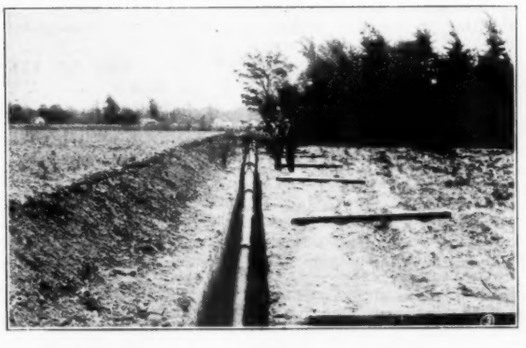
The Cross Lap

Recommended on Pipe Sizes 12″ to 22″

er to Pipe Line for Extra Years of Service

Left: Mr. Cushing, Dearborn Service Engineer, rendering personal supervision — Dearborn Service accompanies Dearborn Products.

Right: No more trouble with this line.



hical Company 299 Broadway New York

DEARBORN CHEMICAL COMPANY NO-OX-ID-IZED WRAPPER NEW YORK CHICAGO

tinctly asymmetric character. Here the steeper side is toward the basin. Although asymmetry is quite characteristic of the anticlines of the Rocky Mountain region and the Lance Creek Field is accordingly typical, it is as common for the mountainward flank, as it is for the basinward side, to be the steeper. In addition to Lance Creek, Buffalo Basin and Mahoney Dome may be mentioned as Mountain region are located on faulted examples of well-developed unfaulted folds yielding gas.

Faulted Anticlines

Many of the gas fields of the Rocky anticlines for folding seems to have been more often accompanied by faulting than not in this area, especially in the larger anticlines. A typical example of a gas pool situated on a faulted anticline is the Elk Basin field of Wyoming, shown on Plate IV. Only the uppermost part of the Elk Basin anticline is shown on this plate and the lowest closing contour would be some distance beyond the borders of the map as the structure has a closure of some 2,000 feet. Though having much more closure than Lance Creek, and in every way a very plainly defined anticline, its crest is not so readily apparent as in the above example, for the reason that the anticline is cut by a number of faults some of which extend across the structure, offsetting the axis, and dividing the fold into several closed blocks. Thus this anticline which has its principal crest along the line common to Section 19, T. 58 N., R. 99 W., and Section 24, T. 58N., R. 100 W., has also a very prominent secondary crest marked by two closed contours in the south half of Section 35, T. 9s., R. 23 E., Montana. Closure is also effected by faulting in Section 30 and again in Section 31, T. 58 N., R. 99 W., and once more in Section 5, T. 57N., R. 99W. The faults are all normal in character and, with two exceptions, all are dip faults. Normal faulting is typical of most of the faulted anticlines in the West, except for an area in north-central Montana, discussed later. In addition to Elk Basin other examples of gas fields on faulted folds are the Garland, Oregon Basin, and Teapot Dome areas in Wyoming.

Structure Closed by Faulting

So far as known to the writer the only productive gas field yet discovered in the mountain states in which the closure of the structure is due principally to faulting is the Hatfield area south of Rawlins, Wyoming. Here a northward plunging anticline is cut by a cross fault in such a manner as to effect closure north of the fault, with little or none of the closure due to folding. This field furnished gas to Parco for some time but is now shut in.

Reverse Faulting

In northern Montana in the region around the Bearpaw Mountains folding is associated with reverse faulting roughly parallel to the axis of the anticlines, a type of structure unique to this particular part of the area described in this paper. Faulting of this kind makes it difficult to predict just what succession of beds may be drilled into below the surface, but aside from the extra hazard it adds to prospecting, this type of structure should afford equally as good a trap for gas as do less complicated structures. That this is so is shown by holes drilled on such structure near Havre where gas was encountered in sufficient amount to supply the town for years. Another example of production obtained under such conditions is that on a small structure south of the Bearpaw Mountains where a hole starting in the Eagle sandstone (Cretaceous) at the surface, found the Eagle repeated by reverse faulting and encountered a flow of 6,000,000 cubic feet of gas in it at a depth of 1,748 feet. The Bowes gas field near Chinook is located in the area typified by folding associated with reverse faulting.

Closure Absent

In a few localities structure is of minor or no importance and the accumulation of gas is due to the lenticularity of the productive horizon. This seems to be true to a large extent of the gas in the Kevin-Sunburst Field in northern Montana and is wholly true of the gas developed from the Farmington sand in the area near Aztec, New Mexico.

Reservoir Rocks

In the western states gas is for the most part produced from sands on closed geologic structures. It is true that it is sometimes found in shale or sandy shale off structure, but except for a well in the Boulder Field which supplied that town for many years, but is now abandoned, gas from shale has not yet been of much commercial importance in the western states. In the Rocky Mountain region proper, gas in commercial amount has not been produced from limestones.

Character of Sands

Though of widely different age, the various sands constituting the reservoir rocks of the district vary little in their composition as seen without the aid of the microscope. They are all medium to coarse in texture and composed of quartz, quartzite, or chert grains, with only minor amounts of other minerals. The cementing material is predominantly calcareous. Generally the sands are gray in color when brought up in the sand pumping, the color being due to the mixture of dark opaque grains with the translucent quartz grains common to all sands of the region. Although gray in the drill cuttings and often on the outcrop, many of the sands are nevertheless buff to brown where exposed at the surface.

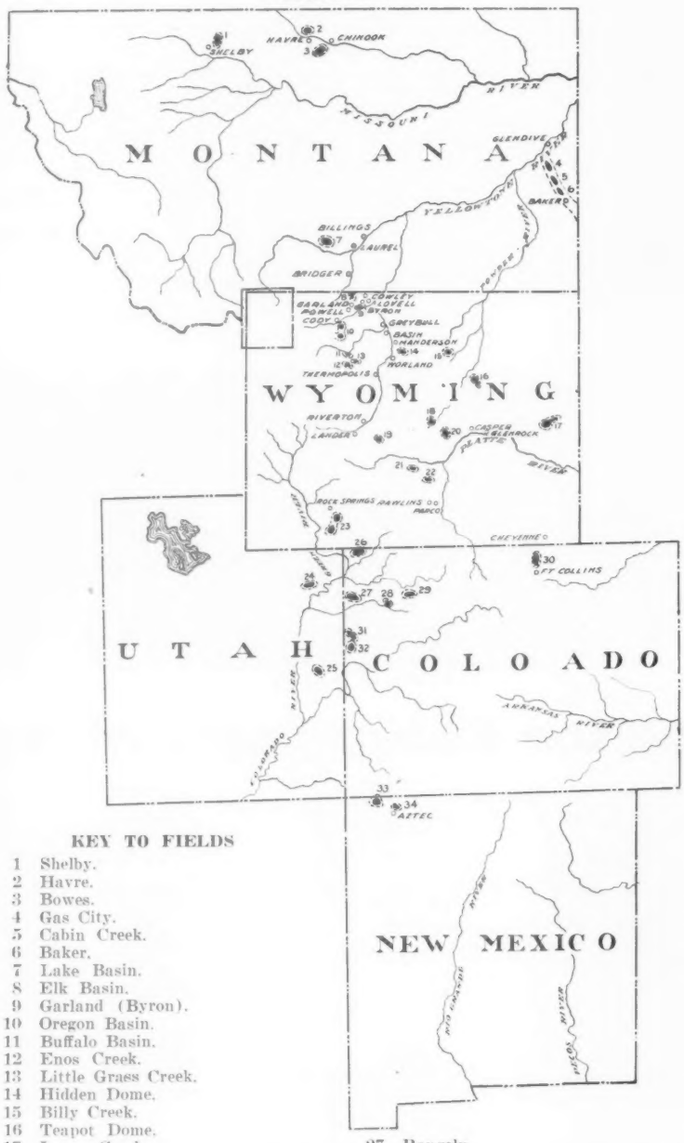
Porosity

Little information is available as to the porosity of sands in the Rocky Mountain region as this is a subject which has only lately been given detailed consideration by the operators. Therefore, the following determinations made by A. F. Melcher and published in a report by A. E. Fath[1] are valuable:

	Porosity Pct.
Wall Creek Sand (Top member of Frontier) Bair Well No. 32, Sec. 10, T. 26 N., R. 90 W.	20.1
Outcrop, Sec. 23, T. 27 N., R. 89 W.	19.9
Muddy Sand (Top member of Dakota Group) Outcrop, Sec. 12, T. 27 N., R. 89 W.	17.9
Outcrop, Sec. 33, T. 27 N., R. 88 W.	13.8
Well on Wertz Dome, Sec. 7, T. 26 N., R. 89 W.	11.4

[1]Fath, A. E., Oil and Gas Fields of the Lost Soldier-Ferris district, Wyoming. U. S. Geol. Survey, Bull. 756, 1924, pp. 55.

INDEX MAP OF GAS FIELDS IN ROCKY MOUNTAIN REGION



KEY TO FIELDS

1 Shelby.
2 Havre.
3 Bowes.
4 Gas City.
5 Cabin Creek.
6 Baker.
7 Lake Basin.
8 Elk Basin.
9 Garland (Byron).
10 Oregon Basin.
11 Buffalo Basin.
12 Enos Creek.
13 Little Grass Creek.
14 Hidden Dome.
15 Billy Creek.
16 Teapot Dome.
17 Lance Creek.
18 Boone Dome.
19 Big Sand Draw.
20 Poison Spider.
21 Wertz.
22 Mahoney Dome.
23 Baxter Basin (Rock Springs).
24 Ashley.
25 Cisco.
26 Hiawatha Dome.
27 Rangely.
28 White River.
29 Thornburg.
30 Fort Collins.
31 Carbonera.
32 Garmesa.
33 Ute Dome.
34 Aztec.

Towns shown are supplied with natural gas.

Continuity

As has been pointed out in the discussion of stratigraphy above, the principal producing sands in the Rocky Mountain region occur in the Jurassic and Cretaceous, although in northwestern Colorado gas is known in the Tertiary. On account of the conditions under which the Tertiary was laid down, it is to be expected that the sands will not be continuous over long distances. In fact drilling on the White River Dome has borne out this theory for there certain wells have failed to find sands productive in other nearby wells. Thus, while individual sands appear very limited in extent, it is interesting that gas is found in other sands in the same zone so that the absence of a particular bed does not necessarily indicate an absence of production.

The highest productive horizon below the Tertiary is found in northwestern New Mexico where the Farmington sand near Aztec yields sufficient gas for domestic consumption in town. This sand is known to be extremely lenticular and it is really to this characteristic, rather than geologic structure, that the accumulation of gas at this locality is due. Below the Farmington sand, and separated from it by a thick series of intervening shales and minor sandstones, is the Pictured Cliffs sandstone which has lately been found productive of gas in this general locality. Little is known of the possibilities of this sand as yet but it is fairly continuous over much of northern San Juan Basin, although not recognized elsewhere in the Rocky Mountain area.

The Eagle and Virgelle sandstones at the base of the Mesaverde group and yielding gas at several localities in the north half of the Rocky Mountain region, appear to be more widely continuous than those mentioned above. It is thought, however, that this supposed continuity will probably be found, as more is learned of the formation, to be more apparent than real. Nevertheless it is likely that the sandstone lenses, if such they be, in this part of the section will prove of large extent, persisting in thickness and lithologic characteristic over relatively wide areas and not limited to a few acres or hundreds of acres as seems to be true, at least in part, for the Tertiary sands.

The Frontier sands (Wall Creek, Torchlight and Peay of various districts) are known to be broadly lenticular. It is true, however, that at certain horizons in the formation, especially at the top and near the base, sandstone beds are found over a large territory, although the sandstones may not be single continuous layers.

Dakota Sand

The Dakota sand, one of the largest producers of natural gas in the western states, was once thought to have been originally deposited as an uninterrupted unit over most of the Rocky Mountain region. Later study has definitely shown that this sand was laid down near an advancing shoreline so that it is of somewhat different age at various localities, and it is easy, realizing this, to understand why the Dakota is not everywhere continuous. It is absent at places in Wyoming and as well as over much of northern Montana.

As is to be expected from the nature of their origin, the sands of the Lower

Specify Meco

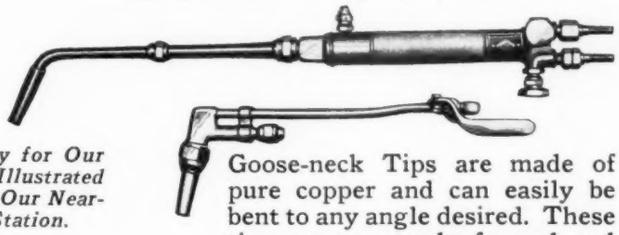
Oxy-Acetylene Welding and Cutting Apparatus Particularly Designed for Every Refinery and Pipe-Line Need

Type G. C. Mult-Seat Oxygen Regulator $25.00

Four Seats Instead of One Insures Four Times Greater Life.

Ease of Repair Warrants Your Investigation.

Type T. P. Combination Pipe-Line Welding and Cutting Torch, 6 welding tips and 3 cutting tips $45.00



Write Today for Our Complete, Illustrated Catalog and Our Nearest Service Station.

Goose-neck Tips are made of pure copper and can easily be bent to any angle desired. These tips are accurately formed and produce the perfect cone flame, so necessary for good pressure welding.

There's a Meco Service Station Conveniently Near You

Modern Engineering Company

Main Office and Factory 3411-13 Pine Blvd., St. Louis, Mo.

Ouachita Natural Gas Company, Inc.

S. D. HUNTER, President
SHREVEPORT, LA.

Monroe, Louisiana

Producers and Distributors of Natural Gas

Domestic and Industrial

This Company has distributed Ten Billion Cubic Feet of Natural Gas yearly for the past ten years

FORMATION IN THE

Era	System	Series	Sweetgrass Arch Montana	Central Montana	Elk Basin and Adjacent Territory Wyoming and Montana
	Quaternary		Alluvium, Pleistocene glacial drift	Alluvium and gravel	Alluvium and gravel
Cenozoic	Tertiary	Miocene?			
		Eocene		Fort Union formation 1,850′-1,950′	Wasatch formation 2,000′-3,000′ Fort Union formation 5,000′+
	Tertiary?	Eocene?		Lance formation 820′	Lance formation 620′
Mesozoic	Cretaceous	Upper Cretaceous	Bearpaw shale 450′-550′	Bearpaw shale 1,100′ Judith River formation 200′	Bearpaw shale 220′ Judith River formation 570′
			Two Medicine formation 1,800′-2,100′	Claggett formation 430′	Claggett formation 720′
			Virgelle sandstone 200′-290′	Eagle sandstone 120′-200′	Eagle sandstone with Elk sandstone member at base
					Niobrara shale 1,590′
			Colorado shale 1,600′-1,750′	Colorado shale 1,740′	Carlile shale 100′ Frontier formation 420′ (Torchlight sandstone 85′; Peay sandstone 85′) Mowry shale 180′ Thermopolis shale 350′
				Cat Creek sandstone 30′-50′	Cloverly formation 265′ (Greybull sandstone; Shale; Conglomerate)
		Lower Cretaceous	Kootenai formation 420′	Kootenai formation 500′	
				Morrison formation 400′	Morrison formation 185′
	Jurassic		Ellis formation 150′-200′	Ellis formation 200′	Sundance formation 200′-350′
	Triassic				Chugwater formation 600′-800′
Paleozoic	Carboniferous				Embar formation 80′-200′
		Permian		Quadrant formation 1,288′-1,670′	Tensleep sandstone 30′-360′ Amsden formation 100′-200′
		Pennsylvanian	Madison limestone 600′-800′	Madison limestone 1,950′	Madison limestone 700′-1,000′
		Mississippian	Press Bul. U. S. G. S. U. S. G. S. Bul. 641-C	U. S. G. S. Press Bul. U. S. G. S. Bul. 786-B	U. S. G. S. Bul. 691-D U. S. G. S. P. P. 53

Cretaceous (Cloverly, Kootenai, etc) are markedly lenticular, but no section is entirely lacking in sands. Of the several beds, the basal conglomerate of the Cloverly and its equivalents is apparently most widespread.

Little study has been made of the continuity of the Jurassic sands but, because of their marine deposition over much of Montana, Wyoming and northwestern Colorado, it is thought that individual sands may prove quite extensive laterally.

Analyses of Natural Gas

The following tables gives analyses of natural gas in several widely separated fields of the Rocky Mountain region. These analyses furnish the reader a general idea of the character of the gas in the area as a whole:

	Kevinburst, Mont.	Mahoney Dome, Wyo.	Baxter Basin, Wyo. (as rec'd.)	Baxter Basin, Wyo. (air free)
Carbon dioxide	0.81	Trace	1.0	1.3
Carbon monoxide		0.0	0.1	0.1
Oxygen	0.14	0.0	4.7	0.0
Nitrogen		1.8	23.5	6.1
Methane	94.15	98.0	70.5	92.2
Ethane	3.97			
Olefins		0.0	0.2	0.3
Sulphur		0.		
Residue	0.93			
B.t.u.	1,020.	1,050.	797.	1,040.
Spec. grav.			.705	.614

Unusual Natural Gases

At several localities in the mountain states natural gas of unusual types has been discovered and deserves mention in a report of this type. These occurrences are, however, not listed in the table summarizing the data on the gas fields of the area, for the reason that these discoveries, though extremely interesting, are of doubtful or no commercial value at present.

Northeastern New Mexico

A few years ago the Standard Oil Co. of California drilling in Section 15-23n-24e, Colfax County, discovered gas consisting largely of carbon dioxide in a sand at 1,509 feet. The initial flow from this horizon was estimated at 250,000 million cubic feet daily. Gas of somewhat similar character was encountered about the same time by the Arkansas Fuel Oil Co. in their well drilled in Section 11-19n-21e, in which a small yield was found in a sand from 1,140 to 1,163 feet, while a second sand, from 1,420 to 1,425 feet, yielded 5,000,000 cubic feet a day. The deeper sand in this well probably about corresponds stratigraphically to that found in the Standard Oil Co. of California well and at each locality the sand is Triassic in age. Both holes started in the Dakota sandstone (Upper Cretaceous) and both are now abandoned. The following analyses of gas from these two wells is taken from a recent report by W. B. Lang* of the United States Geological Survey:

	Well of Ark. Fuel Oil Co. Per Cent	Well of Stand. Oil Co. of Calif. Per Cent
Carbon dioxide	90.0	67.0
Oxygen	2.2	4.1
Nitrogen	7.8	28.7
Methane	0.0	...
Ethane	0.0	...

*Lang, W. B., Unusual Natural Gases, Bull. Am. Assn. Pet. Geol., Vol. 10, No. 11, 1926, pp. 1,176-1,177.

Y MOUNTAIN REGION

Central Wyoming	South Central Wyoming	Northwest Colorado and Adjacent Part of Wyoming	Region Along Rocky Mountain Front Colorado	San Juan Basin New Mexico and Adjacent Territory
Alluvium and gravel	Alluvium and gravel	Alluvium terrace gravels	Alluvium and gravels	
White River formation	North Park formation	Browns Park formation 1,200′+		
		Unconformity		
	Hanna formation 7,000′	Bridger formation	Denver formation	
		Local unconformity		
Wasatch formation 2,400′ Fort Union formation 2,000′		Green River formation 1,500′ Wasatch formation 3,000′-5,000′	Arapahoe formation	Wasatch formation Formation undetermined 250′ Torrejon and Puerco formations 400′-1,400′
	Unconformity	Unconformity	Unconformity	
Lance formation 3,200′	Ferris formation 6,500′	Post Laramie formation 0′-800′		Ojo Alamo sandstone 60′-400′
		Unconformity		
				Kirtland formation including Farmington sandstone member 700′-1,180′
	Medicine Bow formation 6,200′	Laramie formation 1,020′-2,350′	Laramie formation	Fruitland formation 230′-425′
				Pictured Cliffs sandstone 50′-275′
Lewis shale 1,400′	Lewis shale 680′	Lewis shale 900′-1,600′	Fox Hills formation 1,300′	Lewis shale 75′-1,710′
Teapot sandstone 50′		Williams Fork formation 1,600′-3,400′		Cliff House sandstone 375′-750′
Mesaverde formation 845′: Shale member 325′	Mesaverde formation 1,700′-2,200′	Mesaverde group	Pierre shale 5,000′	Mesaverde group: Menefee formation 350′-1,000′
Parkman sandstone 470′		Iles formation 1,350′		Point Lookout sandstone 300′
le shale with Shannon sandstone member 2,275′	Steele shale 4,000′-4,750′			
Niobrara formation 735′	Niobrara formation and		Niobrara formation 400′	
Carlile shale 220′	Carlile shale 1,425′-1,600′	Mancos shale 5,085′-5,370′		Mancos shale 500′-1,200′
ntier formation contains Wall Creek sandstones 935′	Frontier formation 263′-705′			
Mowry shale 280′	Mowry shale 200′-300′		Benton formation 100′	
Thermopolis shale 205′	Thermopolis shale 50′-135′			
Dakota group 304′: Dakota sandstone; Lower Cretaceous shale; Lower Cretaceous sandstone	Dakota group 245′	Dakota sandstone 155′-250′	Dakota sandstone 400′	Dakota sandstone 0′-295′
Morrison formation 250′	Morrison formation 400′	Unconformity Morrison formation 500′	Morrison formation 200′-250′	Mt. Elmo or Morrison formation 400′-700′
Sundance formation 150′	Sundance formation 300′	Twin Creek formation 125′ Nuggett formation 950′		Navajo formation 400′-1,000′
Chugwater formation 1,000′	Chugwater formation 1,400′	Ankareh shale 200′		Todilto formation 3′-200′ Wingate sandstone 30′-450′ Chinle shale 1,182′ Shinarump Conglomerate 20′-100′
		Unconformity		
		Thaynes formation and Woodside shale 760′		
Embar formation 225′	Embar formation 200′-400′	Park City formation 115′	Lykins formation 800′	DeChelly sandstone 0′-585′ Moenkopi formation 300′-500′
Tensleep sandstone 200′ Amsden formation	Tensleep sandstone 150′-175′ Amsden formation 210′	Weber quartzite 900′ Unnamed formation 525′	Lyons formation 297′ Fountain formation 500′-600′	Goodridge formation 1,500′
Madison limestone	Madison limestone 165′	Unnamed formation 600′	Millsap limestone 100′	
		Unconformity		
U. S. G. S. Bul. 626 U. S. G. S. Bul. 641-I U. S. G. S. Bul. 670 U. S. G. S. Bul. 751-A	U. S. G. S. Bul. 756	U. S. G. S. Bul. 751-G	U. S. G. S. Bul. 265 U. S. G. S. Bul. 751-A	U. S. G. S. Bul. 716-E U. S. G. S. P. P. 93

Utah

A well started in 1922 by the Utah Oil Refining Co. on the Woodside Dome in Section 12-19s-13e, Emery County, obtained in a sand from 3,120 to 3,165 feet a flow of noninflammable gas estimated at 20,000,000 feet per day. The rock pressure was 900 pounds. On account of the helium content of this gas the well and all acreage on the structure were taken over by the United States Government and included in Helium Reserve No. 2. The well was never produced and is now plugged and abandoned.

Carbon dioxide gas was found on the Farnham Dome in Section 12-13s-11e, Carbon County, in a hole drilled by the Utah Oil Refining Co. This well is abandoned.

Colorado

The Continental Oil Co., drilling on the McCallum Dome in Section 12-9n-79w, near Walden, Jackson County, a few months ago encountered a large flow of noninflammable gas in the upper sand of the Dakota group. The gas is supposed to consist largely of carbon dioxide. With this gas there is considerable oil which is difficult to handle because of the refrigerating effect of the gas. Details of this unique occurrence will no doubt be given to the industry at a later date but just now the Continental Oil Co. feels it to its best interests not to supply any data for publication.

Future Outlook

The intensive search for oil and gas in the Rocky Mountain region during the past 10 to 12 years has resulted in the drilling of a great number of favorable looking areas and the subsequent proving or disproving of their value for oil or gas. Therefore, while it is not reasonable to expect that no new gas fields will be brought in during the coming years, because of prospecting already done one can only anticipate that discovery of new gas fields will be a considerably more rare occurrence in the future than it has in the past.

For the future perhaps as promising prospecting ground as any in the Western States is the district in north-central Montana adjacent to the Great Northern Railway where gas has been found in the Eagle sandstone under peculiar structural conditions characteristic of that area. Although the wells already drilled do not yield large volumes of gas, and although there seems little reason to expect better wells will be discovered, yet because of the size of the territory it is possible that sufficient production may be developed from numerous holes to warrant a considerable expansion of the natural gas industry there.

The known presence of large amounts of gas in several structures in northwestern Colorado, at present unutilized, together with unused reserves in the Baxter Basin (Rock Springs) Field in Wyoming, will no doubt eventually result in a large increase in the marketable part of the industry in that portion of the Rocky Mountain region. There is, therefore, much reason to expect that in this locality the future will witness considerable expansion in the industry.

Carbon Black a Vital Business Need

Modern Printing Impossible Without It, While It Has Trebled Life of Automobile Tires. Aids Gas Development

By Reid L. Carr
Secretary of Columbian Carbon Co.

Carbon black is the name commercially applied to a unique pigment made by impinging a natural gas flame upon a metallic surface. Its distinguishing qualities are intensity of color, miscibility with oil, rubber and other plastics, and a fineness of particles that is beyond the resolving power of the strongest microscope. It is by far the most finely divided pigment known to man. Hence, it has been fancifully but aptly called "congealed smoke." No doubt the minuteness of its particles accounts for its remarkable covering power when mixed with oil to make ink, and for its extraordinary action as a reinforcing or strengthening agent in rubber compounds.

Carbon black must not be confused with lamp black, which is a pigment made by burning creosote oil in a furnace and collecting the combustion products in a condensing chamber. While chemically similar, lamp black differs from carbon black in molecular structure, tinctorial strength and particle size and, for the most part, in its industrial uses. The two are no more interchangeable than butter and cheese.

A still broader distinction exists between carbon black and the pigment now made from natural gas by thermal decomposition. The latter is undeniably useful, within a limited field, but differs from true carbon black even more than does lamp black in color, weight, structure, covering power and reinforcing quality. It is not a substitute for or competitor with carbon black.

Rotary Press Aided Growth

Contrary to the general impression, the manufacture of carbon black is no innovation but an established business which has been conducted for half a century. Its origin and growth were coincident with the development and general adoption of the modern rotary printing press, which requires a thin rapidly flowing ink of great covering power. Within the past decade, a great impetus was given to the industry by the discovery of the value of carbon black in rubber compounds—one of the most notable achievements of the rubber chemist since Goodyear's discovery of the art of vulcanization.

At the present time there are some 63 carbon black factories in operation, located in the states of Louisiana, West Virginia, Texas, Kentucky, Montana, Wyoming and Colorado. Naturally, they are for the most part situated in areas where the supply of gas outruns the demand. Hence, they furnish a market for gas that would otherwise be unsalable.

Originally, Pennsylvania was the seat of the industry. As gas in that state became more valuable, the manufacturers reached out for a cheaper supply, and did much pioneer work in developing the West Virginia gas fields. Fifteen years later, when favorable opportunities arose to sell their West Virginia gas production, they again sought new sources of gas supply for their manufacturing operations. This time their efforts were rewarded by the development of the great Monroe, La., gas field. Within the past two years a number of factories have been built in Texas to utilize residue gas from casing head plants that would otherwise be wasted.

Production Statistics

Production statistics are not available prior to 1919. In that year their compilation was undertaken by the United States Geological Survey. Subsequently, the work was continued by the Bureau of Mines. The following is a summary of the figures contained in the annual government bulletins.

Big Quantity in Storage

Exports in 1925 amounted to 43,182,635 pounds. On December 31, 1925, the producers had on hand stocks of 96,023,448 pounds, or the equivalent of six and one-half months output. While official figures for 1926 are not yet available, it is believed that the industry ended the year with a carry-over of about 100,000,000 pounds.

Fully 80 per cent of the carbon black manufactured today is made by the channel process, which is described in Bulletin 192 of the Bureau of Mines as "probably the best method and the one most extensively employed." In this process the gas flames impinge upon slowly moving channels on which the black is deposited. It is scraped off the channels by scrapers and conveyed by a screw conveyor to the packing house, where it is bolted, compressed and packed in 12½-pound paper bags. The process is automatic, continuous and very economical of labor. The collecting system is admirably simple and effective. Power is obtained without cost by utilizing the gas pressure. Some plants employ rollers, rings or disks instead of channels as collecting surfaces, but comparatively few plants of those types have been built in recent years.

Inventors have been extremely fertile in suggesting new methods of making carbon black. The patent literature discloses some 75 patents on the subject, but most of them have proved of no commercial value, generally because the inventor has failed to grasp the real problems involved, which are primarily that of particle size and structure, and secondarily that of economical collection. Hence he has satisfied himself by producing the largest possible yield of a black carbonaceous material without bothering to ascertain how it is to be collected or whether it will satisfy the exacting technical requirements of the ink maker, rubber chemist and other users. So instead of revolutionizing the industry, he has eventually found that his product is of no use, except possibly to blacken the face of a minstrel.

Important Characteristics

The truth is that the element carbon is a veritable Proteus, appearing in such diverse forms as the diamond, coal, asphalt, pitch, graphite, charcoal, coke, retort carbons, carbon black, lamp black, oil, natural gas, rubber and all the bewildering multitude of the hydrocarbon family.

It is not a mere matter of separating the element carbon from a hydrocarbon gas. It is a matter of producing a particular colloidal pigment possessing certain definite properties when employed in paints, inks and rubber compounds.

A hard or gritty carbon, such as collects in the cylinders of our automobile engines, is worse than useless. So is a carbon having a crystalline or graphitic structure. Again, a carbonaceous material may be soft and free from grit, yet utterly deficient in color when mixed with oil or in reinforcing power when added to rubber. Still another refinement on which the rubber chemist insists is that the pigment shall not retard the time of cure of his compound. Even true carbon blacks differ surprisingly in this respect. Without attempting a discussion of the highly technical matters involved, enough has been said to show that a mere increase in yield means absolutely nothing unless accomplished without sacrifice of the essential qualities upon which the utility of the product depends. So far, no one has succeeded in commercially duplicating by any other method the colloidal pigment made by collecting the smoke of a gas flame upon a metallic surface. The channel process is the fruit of fifty years of experiment and experience, and until some way is found to increase the yield without changing the quality, it is safe to say that it will not be superseded.

Use Only Residue Gas

Virtually all the gas now used for carbon black purposes is first passed through a gasoline plant. Only the residue gas remaining after gasoline extraction is consumed in carbon black manufacture. The only exception is in a few isolated cases where the gas is too low in gasoline content to warrant treatment. Thus the industry incidentally makes a material contribution to the natural gasoline supply. For example, the company with which the writer is connected has produced during the past three years an average of 12,000,000 gallons of natural gasoline per year in connection with its carbon black operations, besides buying residue gas from other producers. Except for the opportunity to utilize the residue gas in carbon black manufacture, this gasoline could not have been produced, except at the sacrifice of blowing the residue gas off into the air—a sheer waste of a valuable natural resource.

Compared with such basic commodities as iron, coal or timber, the carbon black business is a small one. Yet, from the standpoint of public convenience and comfort, it is of infinitely greater importance than its statistical position would indicate. Limitations inherent in the transportation of natural gas confine its benefits as a domestic fuel to a favored few—less than 4 per cent of our population—who live within piping distance of the gas fields. But there is hardly a man, woman or child in the United States who does not use carbon black, or some of its products, every day of his life. This may sound like an exaggeration, but it is easily proved.

Use in Printing Inks

First comes its universal use in the manufacture of printing inks adapted for rapid printing. The early printer, laboriously producing a few impressions of his book or newspaper upon a hand press, could collect enough soot for his ink by holding a saucer over the flame of a tallow candle. But the vast expansion of the printing and publishing business which has taken place in our age has brought new requirements as to ink as regards quantity, cost and quality. The

Carbon Black Industry Misunderstood

Criticism is often voiced against the "waste" of natural gas in burning it to make carbon black. The general public fails to realize that almost every man, woman and child in the nation uses carbon black or some of its products every day.

Virtually all the natural gas now used for making carbon black is first passed through a gasoline plant and the gasoline extracted. The company with which Mr. Carr is connected has extracted an average of 12,000,000 gallons of gasoline yearly during the past three years.

Carbon black is indispensable in the making of ink suitable for the fast presses now used in the printing and publishing business. Such printing requires an ink that will flow freely, cover every hair line of the type or cut, and make an instantaneous jet black impression. Carbon black, mixed with mineral oil, provides such an ink.

Carbon black is a most vital factor in making automobile tires. It adds to the tensile strength and resiliency of the tire, toughens the rubber, reduces punctures, increases resistance to abrasion and increases mileage. It was the big factor permitting the manufacture of balloon tires.

A rubber mixture, containing carbon black, has been found under tests to outwear leather ten times and such a mixture resisted the action of a powerful sand blast three times as long as iron.

Carbon black plants are located where there is no market for the gas for domestic or other industrial purposes. Carbon black manufacturers aid in developing natural gas fields. As soon as a market is developed for the gas for use in homes or factories, the carbon black plants are closed and this gas sold for domestic or industrial consumption. Hence, natural gas which might be used in homes or factories is seldom, if ever, used for making carbon black.

CARBON BLACK PRODUCTION—1919-1925

Number of plants—	1919	1920	1921	1922	1923	1924	1925
Quantity (pounds)—	36	35	41	43	69	69	63
West Virginia	29,925,614	26,659,469	25,073,000	20,095,481	20,038,415	15,045,448	10,847,794
Louisiana	14,024,606	18,565,498	31,003,615	41,966,856	101,398,881	144,601,550	129,839,907
Texas	.....	.....	.....	.....	2,633,013	13,764,014	26,219,510
Kentucky, Montana, Wyoming, Pennsylvania and other states	8,106,821	6,096,925	2,697,075 992,625	4,306,875 1,426,917	10,058,887 4,133,452	10,135,435 3,325,587	7,309,378 3,200,789
Total	52,056,941	51,321,892	59,766,315	67,795,129	138,262,648	186,872,034	177,417,378
Average price (cents per pound)	7.3	7.9	9.1	8.6	8.5	6.2	5.4

Southern Mill
Ideal Homes

Model 301

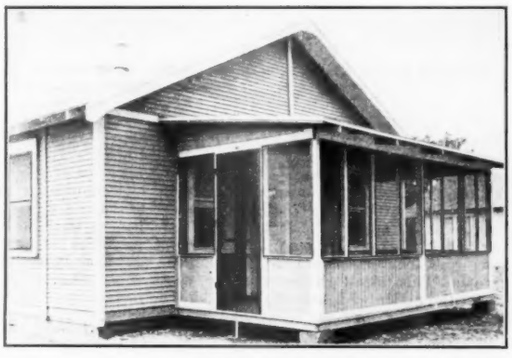
Homes such as these tend to secure more contented and hence more efficient labor. Their first cost is very reasonable and when it is taken into consideration that they can at any time be dismantled and moved the great savings effected can be easily seen.

Model No. 301, illustrated at the right, has a large living room that may also be used as a bedroom. A combination kitchen and dining room and a bedroom.

Model 411

The front porch is built into the house and opens directly into the living room. The back porch is screened and provides a summer dining room or an additional sleeping room during the summer months.

Model 411 has proven to be an ideal home for the oil fields. Its room arrangement cannot be improved. This house makes a fine home for superintendents and is widely used as such. The rear porch illustrated is exceptionally large and roomy. It has a panel extending 2' 5" above the floor with screen above. This makes a very attractive addition to the house and adds much to its value. Porch comes in sections that fit accurately and are easily erected.



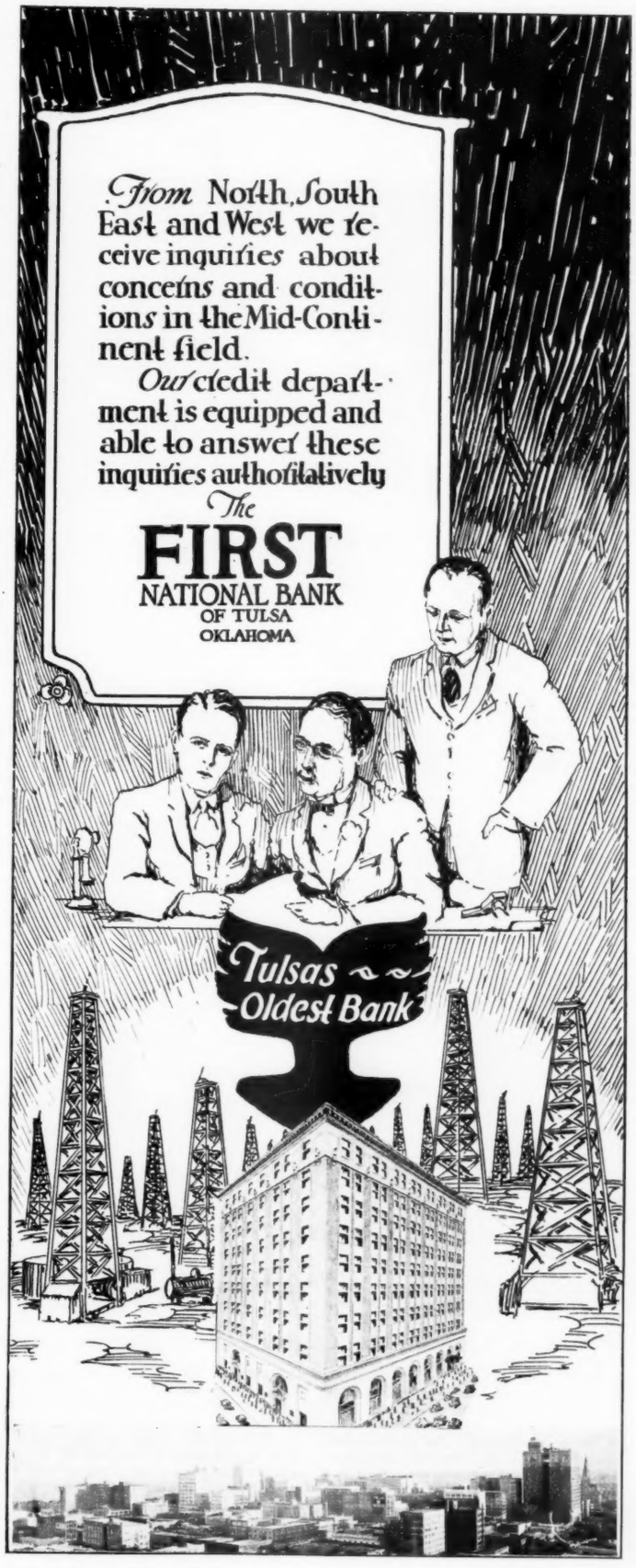
Back Porch

We manufacture these houses in many different sizes and floor plans. They are being widely used throughout the oil fields and the strength of their construction can be easily grasped from the fact that one group of buildings has been moved over seven times.

Write for our illustrated catalog fully describing these buildings, together with floor plans and specifications.

Southern Mill & Manufacturing Co.

Office and Factory: 1645 East Sixth St.,
TULSA, OKLAHOMA


From North, South East and West we receive inquiries about concerns and conditions in the Mid-Continent field.
Our credit department is equipped and able to answer these inquiries authoritatively
The
FIRST
NATIONAL BANK
OF TULSA
OKLAHOMA
Tulsas Oldest Bank

inconceivably rapid operations of the modern multiple press require an ink that will flow freely from the fountain, cover every hair line of the type or half-tone cut and make an instantaneous jet-black impression. For such an ink, carbon black is the ideal and indispensable material.

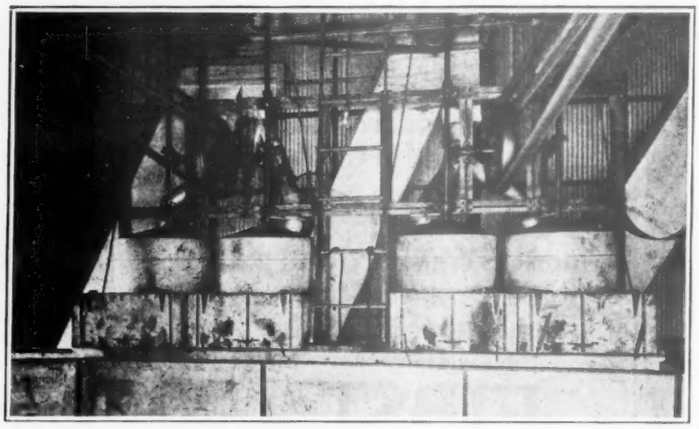
The modern newspaper is dependent in a physical sense upon three natural resources—our forests for its paper, our natural gas and oil for its ink. News inks are made by mixing carbon black and mineral oil in the approximate proportion of one pound of black to eight or nine pounds of oil. **A single pound of carbon black thus mixed with oil will print 20,000 pages of average newspaper size, or the equivalent of nearly an acre of surface.** That is what is meant by "covering power."

To say nothing of books, magazines, or weekly periodicals, it requires 35,000,000 copies per day of our daily newspapers to satisfy the thirst for information of the American public. All this printing is done with ink made from carbon black.

Vital to Rapid Printing

Bulletin 192 of the Bureau of Mines says: "Carbon black is peculiarly suited to the needs of the present methods of printing, the fast-running presses and half-tone illustrations. . . . Ink manufacturers and users believe that carbon black is absolutely essential to their business." The same authority states: "It has been said that the fast-feeding newspaper press of today has been made possible only through the use of carbon black in making long inks." The following is quoted from a publication of the Geological Survey: "The modern rotary printing presses now used by daily newspapers and printing establishments require an ink that will dry rapidly and yet permit the presses to be operated at high speed—an ink that will flow freely, possess great covering power and make an instantaneous and legible impression—and an ink having all these qualities can be made by using carbon black." How important these qualities are is indicated by the fact that the presses now used by some of our large dailies are capable of printing 200,000 pages per hour, or 50 per second. No wonder the National Association of Printing Ink Makers has declared that without carbon black "it would be impossible to continue the supply of ink requisite for printing the newspapers of the United States."

Carbon black is not merely the indispensable adjunct to the printing press. It is also a usual ingredient in carbon papers and phonograph records. Thus it is a medium for the perpetuation of the typewritten and spoken as well as the printed word.



Bolter house in carbon black plant. Carbon black from the burning houses is transported to storage bins.

Makes Tires Tougher

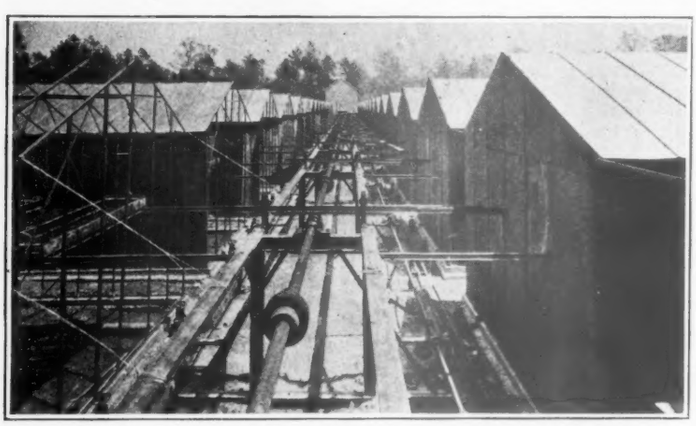
The most remarkable chapter in the story of carbon black has been its world-wide adoption by the rubber trade during the past decade. Those of us who owned automobiles in the early days vividly recall how frequently our pleasure was spoiled by a puncture or blowout. Such incidents were of almost daily occurrence, usually at the most vexatious time and place. Finally, the rubber chemists, after a long search for something that would make tires tougher and more serviceable, hit upon carbon black. Its success was immediate and spectacular. Beginning with one or two of the larger American manufacturers, the use of carbon black in tire tread stocks rapidly spread throughout the entire rubber industry, both in this country and abroad. At least 100,000,000 pounds per year are now consumed by the rubber trade. Virtually all tire treads are black. A tire with a white tread is as rare as the proverbial "white blackbird."

Everybody knows that tires give two or three times as much service as they once did, but few of us have ever troubled ourselves to ask why. Still fewer realize that a natural gas product has anything to do with it. The popular impression probably is that the use of any substance other than rubber in a tire is only to color or cheapen it. But nothing could be further from the truth. Carbon black is universally employed in tire-treads, not because of its cost or color, but because it adds to the tensile strength and resiliency, toughens the rubber, increases its resistance to abrasion, minimizes punctures and blowouts, and so insures greater mileage.

Great Tensile Strength

A simple rubber-sulphur mixture has a tensile strength of 1,150 pounds. By adding an equal weight of zinc oxide, the tensile strength may be increased to 3,400 pounds. But by substituting for the zinc oxide 35 per cent of carbon black, the tensile strength goes up to 4,000 pounds. At the same time the ability of the rubber to store energy, i. e., to take up shocks, becomes almost double that of the zinc oxide mixture. In other words, the carbon black-rubber compound is stronger and more resilient, wears longer and is less susceptible to cuts, punctures or abrasion. Incidentally, the black rubber tire is appreciably lighter than a tire made in the old-fashioned way, which is another advantage. Doctor Geer, in his fascinating book, "The Reign of Rubber," thus sums the matter up:

"The black tread tire has been evolved after a painstaking, intricate study, and the chemists have worked long and diligently in their laboratories to produce such a highly resilient rubber mixture. When tested on machines built for the purpose against the abrasive action of carborundum, these treads outwear dry leather by about two and one-half times; with both materials wet, they outwear leather more than 10 times. An interesting test was run some years ago to compare sheet iron and several rubber compositions. **This black rubber mixture resisted the action of a powerful sand blast three times as long as iron.** The black rubber tread composition on a penumatic tire is the material most resistant to road abrasion that the chemist in his laboratory has been able to produce."



View "down the alley" between the burning houses of a carbon black plant.

Use in Balloon Tires

The advent of balloon tires three or four years ago resulted in a further increase in the use of carbon black. Since balloon tires contain proportionately less fabric than cord tires, they are even more dependent for strength and durability upon the toughness, resiliency and wearing qualities of the rubber compound.

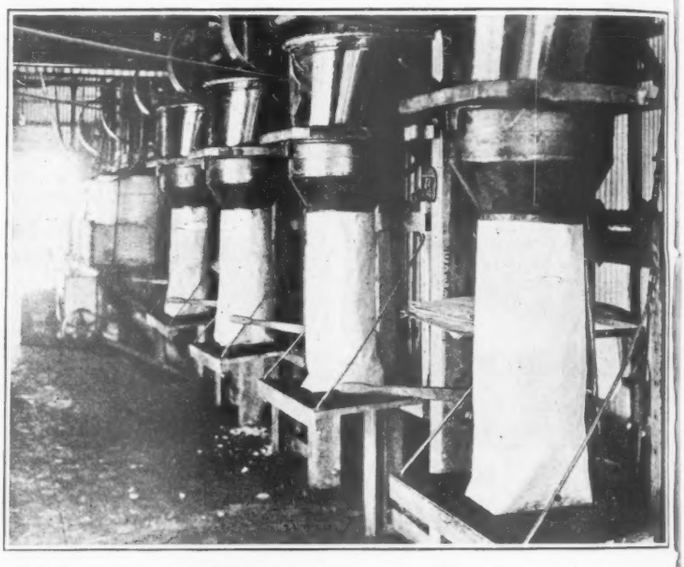
The use of carbon black in rubber compositions is by no means restricted to automobile tires, but has spread to many other articles, such as hose, surgical and mechanical rubber, floor compositions, rubber heels, and all products in which resistance to wear is a prime requisite. One recent development is a rubber device now used instead of a shackle bolt upon trucks and pleasure vehicles. Another is a lining for ball mills, where the durability of rubber reinforced by carbon black has been found superior to that of steel. A probable convenience of the future, already being tried in London, is the rubber road, which will deaden the noise of traffic around hotels, hospitals and congested centers.

In discussing the pros and cons of the carbon black industry, one fact often ignored is the important service which it renders to the 20,000,000 automobile owners of America, not only in minimizing the delays and annoyances of punctures and blowout, once the bete noir of the automobilist's life, but also in prolonging tire mileage, thus materially reducing the cost of automobile transportation. The saving thus effected is many times the cost of the carbon black employed. As the American people spend upwards of $800,000,000 annually for automobile tires, this is a matter of some moment.

Many Other Uses

But we have not yet completed the catalogue of uses of carbon black. Among the many other articles or products into which it enters as an ingredient are stove polish, paints, varnishes, enamels, cement colors, crayons, black and gray papers, book binders' board, linoleum and artificial leather. Certainly few substances have so wide a range of utility.

In recent years there has been a tendency in a few states to hamper or restrict carbon black manufacture by statute. This is perhaps only a manifestation of the prevailing legislative passion for regulating every conceivable form of human activity, from which no business is immune. In the present instance, prejudice has often been fostered by an abysmal ignorance of what carbon black is or what it is good for. Some newspapers have even been guilty of the absurdity of scolding the industry quite intemperately, without pausing to consider that carbon black is one of the basic commodities on which the printing and publishing business depends. With a better understanding of the genuine economic value of the product, such hostility is likely to disappear.



Packing house in carbon black plant. The carbon black is fed into the sacks and automatically weighed.

Quality Real Factor

One criticism frequently made is that the process is inefficient or wasteful. This is based upon a comparison between the quantity of the element carbon contained in a given volume of gas and the quantity of the pigment, carbon black, produced. As pointed out in an earlier paragraph, the pigment is not merely carbon, but carbon in a unique and peculiarly useful form. Surely efficiency must be judged from a qualitative as well as a quantitative standpoint. Unless the critic is prepared to show us how to obtain on a commercial scale a materially larger yield

Staunchly built for Rugged Service

IN THE OIL COUNTRY

"Central" TUBULAR GOODS

Speed . . . safety . . . service . . that's the creed of the oil and gas country. There are no pipe troubles when "Central" Line Pipe is called into action.

Large gas companies, after using "Central" Pipe, have commented upon its uniform lengths, perfect roundness, and careful beveling. These sterling qualities in "Central" reduce construction costs by speeding up the field work and, in addition, insure a tight, durable line.

For complete satisfaction all around use "Central" Pipe on your next job.

Central Tube Company

General Offices: First National Bank Bldg., PITTSBURGH

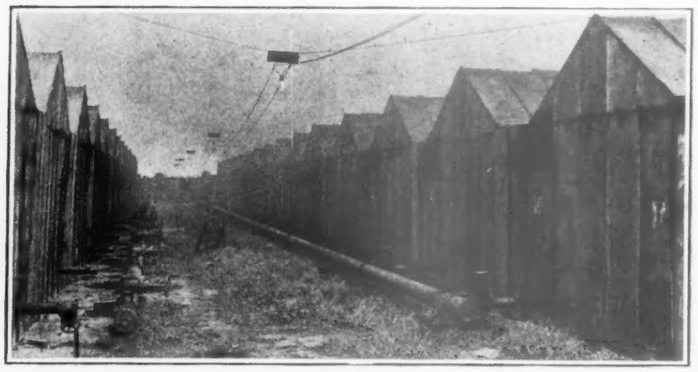
Representatives in the Oil Fields

Mid-Continent: Allen, Sproull & Allen, Burk Burnett Bldg., Fort Worth, Texas.
California. E. C. Saul, Monadnock Bldg., San Francisco, California.

DISTRIBUTORS

Taubman Supply Corporation, Tulsa, Oklahoma, and branches.
Dunigan Tool & Supply Co., Breckenridge, Texas, and branches.
Putnam Supply Company, Putnam, Texas, and branches.
Louisiana Iron & Supply Co. Shreveport, La., and branches.
Petroleum Equipment Co., Los Angeles, California, and branches.
American Supply Co., Mexia, Texas.
Standard Supply Co., Inc., Wichita Falls, Texas.

of a pigment having identical qualities and uses, the criticism is not very persuasive. In fact, the same kind of a case can easily be made against many important industries by the same method of comparing actual results commercially attained with theoretical perfection. Take the incandescent electric light as an example. That has engaged the attention of the best engineering brains in the country, and is probably regarded in the popular mind as quite a miracle of modern efficiency. Yet Henry L. Doherty, speaking of the use of oil or gas fuel to generate electricity for lighting purposes, says, "We lose, first, 83⅓ per cent of our energy in the production of oil or gas from our oil pools. Second, 85 per cent of what remains we lose in the process of transforming heat energy into electrical energy. Third, 90 per cent of what remains we lose in transforming the electrical energy into light." Excluding altogether the field losses to which he refers, the amount of heat energy in the fuel actually converted into light is therefore 10 per cent of 15 per cent, or exactly 1½ per cent. Yet we seldom hear people clamoring for the suppression of incandescent electric lights on the ground that they are only 1½ per cent efficient.



Two carbon black units, or 30 burning houses arranged in two rows of 15 houses to a row.

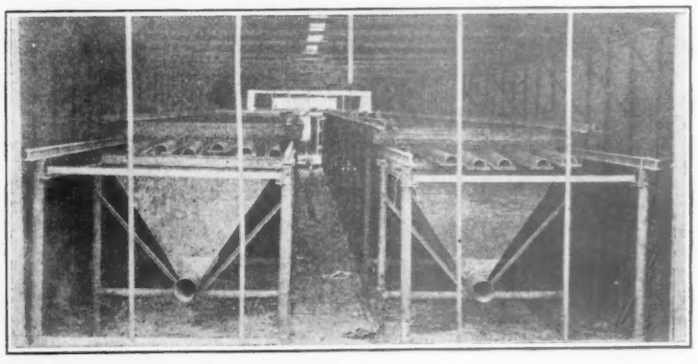
Another Unsound Criticism

The only other criticism of the carbon black industry worthy of notice is the assertion that its continuance is an obstacle to the distribution of natural gas for domestic purposes. It might be suggested that books, magazines, newspapers and automobile tires possibly contribute as much to the welfare and convenience of the people as the use of natural gas fuel. But that answer need not be made, since the fact is that pipe line mileage is greater and domestic gas distribution more general in those states, such as Pennsylvania and West Virginia, which have pursued a "hands off" policy in respect of carbon black manufacture than in those states which have seen fit to adopt a more paternalistic attitude. That is hardly consistent with the notion that carbon black factories impede the distribution of natural gas for other purposes.

The criticism is really founded upon a misconception of the business policy of the carbon black manufacturers. As a matter of fact, they will usually be found only too eager to avail themselves of every opportunity to furnish gas for fuel purposes to other consumers, even though this may involve the curtailment or eventual suspension of their own manufacturing operations. To give a specific illustration, the company with which the writer happens to be connected has within the past few years voluntarily closed five factories in West Virginia, as opportunity arose to market its gas production to pipe lines. Similar action has been taken by several other manufacturers in that State. In Louisiana, our company has striven to the utmost to increase and broaden the market for natural gas, even going so far as to invest several million dollars in building pipe lines and distribution facilities, and diminishing its carbon black operations in proportion as it has succeeded in developing new markets for gas. In consequence of the foregoing policy, it is now selling upwards of 60,000,000 cubic feet of gas per day for industrial and domestic use.

A Business Policy

This is not altruism. It is sound and constructive business policy. Carbon black is undeniably a valuable product, an economic necessity. If at a given time and place, there is no other adequate market for the gas, or if the gas is worth more for carbon black purposes than other consumers will pay, certainly no one can complain if it is converted into products of such genuine public utility as carbon black and gasoline. On the other hand, if there is an adequate market for the gas for other purposes, if other consumers are willing to pay more for it than can be realized by converting it into carbon black, then at that time and place carbon black manufacture is no longer advisable from a business standpoint, and the gas should be sold to those who will pay more for it. It is simply a question of volume and price. If others will not buy the gas in adequate volume, or at a price commensurate with what can be realized by turning it into black, they ought not to expect the owner to shut in his wells, while they are depleting the common reservoir by means of wells upon neighboring acreage. That would savor too strongly of the naive motto of the Scottish borderer: "Rather thou should want than I should want."



Inside view of a double burning house. Six channels for collecting carbon black deposited from the gas tips are shown at top of each of the two pipe frames supporting the burners, channels and hoppers. At bottom of the hopper is the screw conveyor that carries the carbon black to the bolter house.

Ample Room for All

Experience in the natural gas business has convinced the writer that there is no necessary conflict between carbon black manufacture and other branches of the natural gas industry. If each will show a reasonable regard for the other's rights, there is ample room for both to thrive and prosper. There are still many gas fields in which the production far exceeds the requirements for any existing market. That condition is likely to continue in Louisiana, Texas, New Mexico, Colorado, Montana and other states for many years to come. The carbon black manufacturer should seek to locate his factories in such fields, and to aid in their development, avoiding areas where other adequate markets for the gas production exist. By drilling for gas in new fields and furnishing a financial incentive for others to do so, he can perform a highly useful service. If, after his pioneer work is accomplished, opportunities arise to sell gas on fair terms for other purposes, he should be quick to embrace them. He should also actively assist in rendering natural gas fuel available in neighboring communities. The pipe line company or public utility should recognize that natural gas, when reduced to possession, is private property like oil, timber or wheat, and should not expect to monopolize the output of any field except for legitimate purchase. It should recognize that owners of gas wells are entitled to sell or use a fair percentage of their productive capacity—if not for domestic purposes, then for such purposes as are possible in that locality.

As to Legislation

Both have a common interest in discouraging paternalistic legislation on the subject of natural gas. If today the state bans its use in reasonable volume for carbon black purposes, may it not next year, or five years hence, in the supposed interest of domestic consumers, extend the ban to inclue the oil refinery, the glass factory, the smelter or the brick plant? Furthermore, what may be done with one natural resource may be done with another. The state has just as much legal right to prescribe by whom and for what purposes oil or coal shall be used as it has to make similar restrictions in the case of natural gas.

There is a wide field for the exercise of the police power in regulating the drilling, spacing, operation and plugging of wells, protecting the mineral sands from injury through negligent or unskillful practices, and safeguarding the common reservoir against disproportionate depletion at the hands of any land owner. But allowing full scope for public regulation of minerals while they remain in situ, a different situation arises when they have once been taken from the ground. They then become ordinary commodities of commerce—the exclusive property of the owner. The assumption by the state of the right to dictate to whom they shall or shall not be sold, and for what purposes they shall or shall not be used, is fraught with dangerous implications to every person engaged in the oil or gas industry. After all, these are essentially business questions. Is it not wiser to leave their solutions to the free play of economic forces than to the vicissitudes of local politics?

PROTECTING COAL AND OTHER SUCH DEPOSITS WHILE DRILLING FOR GAS

By W. E. Fohl

Specific regulations for the purposes here named have been chiefly directed toward preventing the migration of water, oil or gas from one horizon to another.

On the public domain operating regulations to govern the production of oil and gas have been issued by the United States Geological Survey and revised and approved July 1, 1926. These have been applied in California, Wyoming, Montana, New Mexico, Oklahoma and Colorado. In them lessees are charged to take precautions "to prevent waste of oil or gas, damage to formations or deposits bearing oil, gas, water or to coal measures or other mineral deposits, injury to life or property, or economic waste." The Government's supervisor is directed "to require the correction, in a manner to be prescribed or approved by him, of any condition existing subsequent to the completion of a well which is causing or is likely to cause damage," such as is above specified. The guide for the supervisors is found in Bureau of Mines Bulletin No. 232, "Manual for Oil and Gas Operations," in which may be found in full detail description of methods in use.

Operating regulations to govern coal mining methods on the public domain direct the mining supervisor "to prescribe or approve the methods of protection from oil and gas wells through the coal measures and mines both with respect to prevention of leakage of oil or gas endangering the lives of employes, and also to prescribe or approve methods of obtaining the ultimate extraction, so far as possible, of coal in the vicinity of oil or gas wells."

In only a comparatively few states have methods been prescribed by laws designed to protect the mineral deposits, and such protection has been confined to the coal deposits. They have concerned themselves chiefly with the location of wells with reference to mine openings and buildings, and with the plugging of wells upon abandonment. The methods of plugging prescribed have been designed to interpose a fast seal between oil and gas bearing horizons and the coal measures, and the placing of a similar seal over the coal seam to prevent the intrusion of overlying water.

A committee of the A. I. M. E., acting with numerous representatives of the oil and gas and coal industries is at present concerning itself with the formulation of general recommendations to direct the drilling of oil and gas wells through coal beds. Its final report is still far from completion, but from an examination of its data by the writer it would appear that the items requiring principal attention are:

A precise location of all wells at the time of their drilling, and the placing of these locations in permanent records which will be open to the parties in interest.

A method of drilling and casing which provides for a vent to the surface through which the liquid or gaseous products of the well may escape at all times during the active life of the well.

A method of plugging at abandonment which shall place between the coal bed and the oil and gas bearing strata such seal, or seals, as will confine the oil or gas to its own horizion, and a similar seal over the coal bed to shut off water.

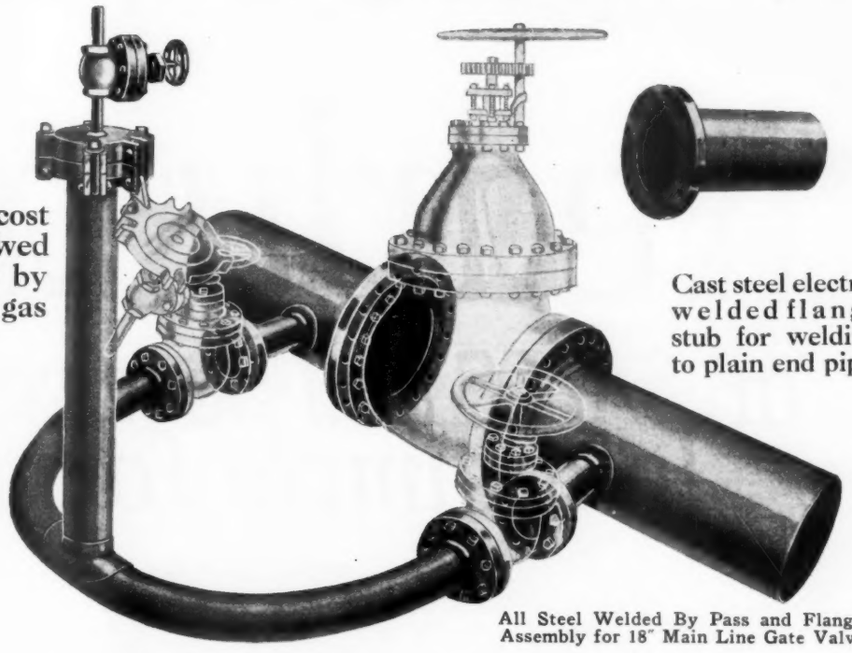
Specifications for coal pillars of a size to preserve the active well intact while surrounding coal is being removed.

Directing attention to the fact that under any scheme of procedure there is potential danger that the liquid or gaseous products of wells may find inlet to mines they penetrate and, therefore, such mines should be operated with all the safeguards customarily used in gaseous mines.

HENDERSON Cast Steel Electric Welded Flanges

are being used exclusively on High Pressure Natural Gas Lines

The slight additional cost over that of the screwed joint is quickly offset by positive elimination of gas leaks.



Cast steel electric welded flange stub for welding to plain end pipe.

All Steel Welded By Pass and Flange Assembly for 18" Main Line Gate Valve

THE W. K. HENDERSON IRON WORKS & SUPPLY CO., Shreveport, La., U.S.A.

Manufacturers of Oil and Gas Line Specialties

THE PALMER CORPORATION

PRODUCERS OF NATURAL GAS

CITY BANK BUILDING

SHREVEPORT LOUISIANA

SALES and SERVICE

WESTCOTT & GREIS INC. W&G MEASUREMENT & CONTROL

Nearly a Qu

of SALES and Service has reduced to a simple formula:

Sales and Service

THE PETROLEUM APPLIANCE CO. (THE MASTER MIXER HEAD)
CROSBY STEAM GAUGES AND VALVES.
LIQUID SAFETY VALVES and companion line of safety tank equipment.
WESTCOTT ORIFICE METERS.
METRIC IRONCASE METERS.
DAVIS SUPERSENSITIVE RELIEF VALVE AND CASING HEAD REGULATORS.

CHAPLIN-FULTON high and low pressure regulators.
MERIAM MANOMETERS and companion line of Meriam Products.
MacDONALD 2Lt. 3 Diaphragm Meters equipped with 4 purging cocks for laboratory and charcoal testing.
BRISTOL'S CHARTS AND RECORDING GAUGES.
KREB'S LEVELING SADDLES.

Westcott & Greis, Inc.
MEASUREMENT AND CONTROL

SALES and SERVICE

WESTCOTT & GREIS INC. W&G MEASUREMENT & CONTROL

uarter-Century

ued MEASUREMENT and CONTROL

"Ask Westcott and Greis"

Since 1904 a service has been shaping itself to meet the growing demands of the Oil Industry. For almost twenty-five years, technical questions—plans and problems—relating to Measurement and Control of gases, water, oil and steam in the gas, natural gasoline, refining and producing divisions, have been multiplying and intensifying. During these years Westcott and Greis, Inc., has stepped off each milestone of progress side by side with the Industry.

A staff of able technical advisors, unlimited facilities, ample stocks strategically located, insure those in search of installation counsel or practical methods for meeting their measuring and controlling problems, a speedy and economical service that never fails of results, though the situation to be faced be one without precedent.

So faultless and dependable has this service become, in the sales and service of the MEASUREMENT AND CONTROL devices listed on the opposite page, that those whose work lies in keeping accurate check and control of steam and liquids, as well as those who are responsible for the economy and production of plant and lease operation, regard Westcott and Greis as a tangible asset in making their work easier and more profitable.

This growing tendency on the part of field and office men to take advantage of Westcott and Greis' quarter-century of experience has established a simple formula which can be applied to your own problems with equal efficacy: "Ask Westcott and Greis."

Dallas — TULSA — Los Angeles

Westcott & Greis, Inc.

MEASUREMENT AND CONTROL

Use of Rotaries to Drill Gas Wells

Objections Previously Expressed Overcome by Improvements by Makers of Equipment and Careful Crews

By C. P. Parsons
Superintendent, Cement Oil Field and Chickasha Gas Field, Magnolia Petroleum Co.

It is assumed that most readers of The Oil and Gas Journal are acquainted with rotary equipment, but before going into the detailed application of this equipment to the drilling of gas wells, a few paragraphs will be given to a brief description of this younger member of the drilling family for the benefit of interested readers in the gas industry whose duties keep them afar from field operations.

Let us decide to drill a well in a gas field and rotary is to be our method. We have decided on rotary because of its speed and economy. This economy is chiefly effected by the fact a rotary usually is able to drill thousands of feet without running casing, the hole standing up due to the pressure of the column of rotary drilling mud on the wall and the plastering effect of the revolving drill pipe. Rotary is a hole making outfit, but finding the pay formation is often the bugaboo when wells are drilled down and brought in by rotary instead of the common practice of drilling to a certain point with rotary, setting casing and then replacing the rotary with cable tools to find the sand. This change from rotary to cable tools is very expensive, requiring a complete change of men and equipment. Rotary requires a hole full of circulating mud (with an exception explained later), while cable tools drill with a small amount of drilling water or light mud through which a producing sand will easily show.

How does rotary attempt to overcome this apparent difficulty in finding producing formations? By manufacturers' developing core barrels, rotary sand testers, etc. By the operators' developing the human element, the crews and field men, into looking ahead and studying formations as indicated while drilling by the combined actions of the movement transmitted from the rotating bit to the drill stem, the laboring of the pumps and the amount of feeding off from the drum of drilling line during the hole making; also by the human elements making a careful study of the field as a whole, particularly subsurface conditions.

The importance of well-kept drilling records or well logs should be stressed, and hole measurements checked at important places by steel line.

Rotary Equipment

We will assume we have our human element lined up for our well and it is time to choose our equipment. The most widely used equipment at present consists of two or more boilers, twin drilling engine, three-speed double-brake draw works, drilling line, five sheave crown block, four sheave traveling block, spring hook, chain driven rotary, drill pipe, float valve, drill collar and bits, a few fishing tools, tongs, hand tools, core barrels, etc. Detailed cuts and descriptions of these can be found in manufacturer's or supply house catalogs.

The twin drilling engine is more suitable for rotary drilling because of its flexibility, constant power and quick reversibility. The three speed draw works has its advantages in allowing increased speed as the load lightens in pulling drill pipe; the time thus saved is very important when coring, fishing, etc. The drill pipe mostly used for drilling 9-inch or larger holes is 6-inch internal upset, 22 pounds to the foot; 4-inch drill pipe for 8-inch hole; 3-inch drill pipe for 6 and 5-inch holes, and 2½ or 2-inch drill pipe for smaller holes. The tendency has been to replace the 6 and 4-inch drill pipe with just one string of 5-inch internal upset, 22 pounds to the foot, for holes between 7⅞ and 17-inch, which are most common in drilling gas wells in the Mid-Continent. The types of drilling bits used are fishtail, cone rock bit, roller rock bit and disc bits. Efforts are being made to perfect a collapsible bit that is lowered or pulled through the inside of drill stem to obviate the necessity of pulling the drill pipe to change bits.

For our well we have had a derrick, built high enough to allow the drill pipe to stand in "fourbles" with a clearance at top for the traveling block, hook and elevators. To conform with state law it has a crow's nest on top and a fourble board with a platform around it on which the derrick man works. The writer has had satisfaction with a 116-foot steel derrick, which on account of its ruggedness and portability is suitable to a gas field where no derricks are left standing.

The slush pit is on the same side of the derrick as the pumps and is divided in three parts, the circulating pit, settling pit and reserve pit. The rotary mud on coming out of the hole runs along a trough or ditch, the long way round to the settling pit where the cuttings settle out and the drilling mud flows over a baffle into the circulating pit to be picked up by the pumps; the reserve pit holds excess mud not needed for drilling.

We have fuel and water lines laid to the location, erected a water tank and are ready to load the rotary on a fleet of 2½-ton trucks or on wagons.

Transportation

"By gawd! weren't those roads h——? . . . Wonder how many trucks are bogged down? . . . Looks like this place oughter produce gas or oil . . . ain't good for nothing else. . . . Hope tuh h—— it don't rain! etc." That is the usual transportation problem in delivering the equipment to the location.

Rigging Up

Our drilling crews, one for each daily tour of 12 or 8 hours, are a husky lot and are now rigging up our rotary that caused us to stand those penetrating scrutinies of credit men.

After three or four days wrestling with boiler and pump connections, placing the rotary and dozens of miscellaneous gadgets, the crews are rarin' to make hole.

Some of the following subjects are worthy of separate articles but an attempt is made here to cover them concisely but in a practical, nontechnical way.

Keeping Ahead of Trouble

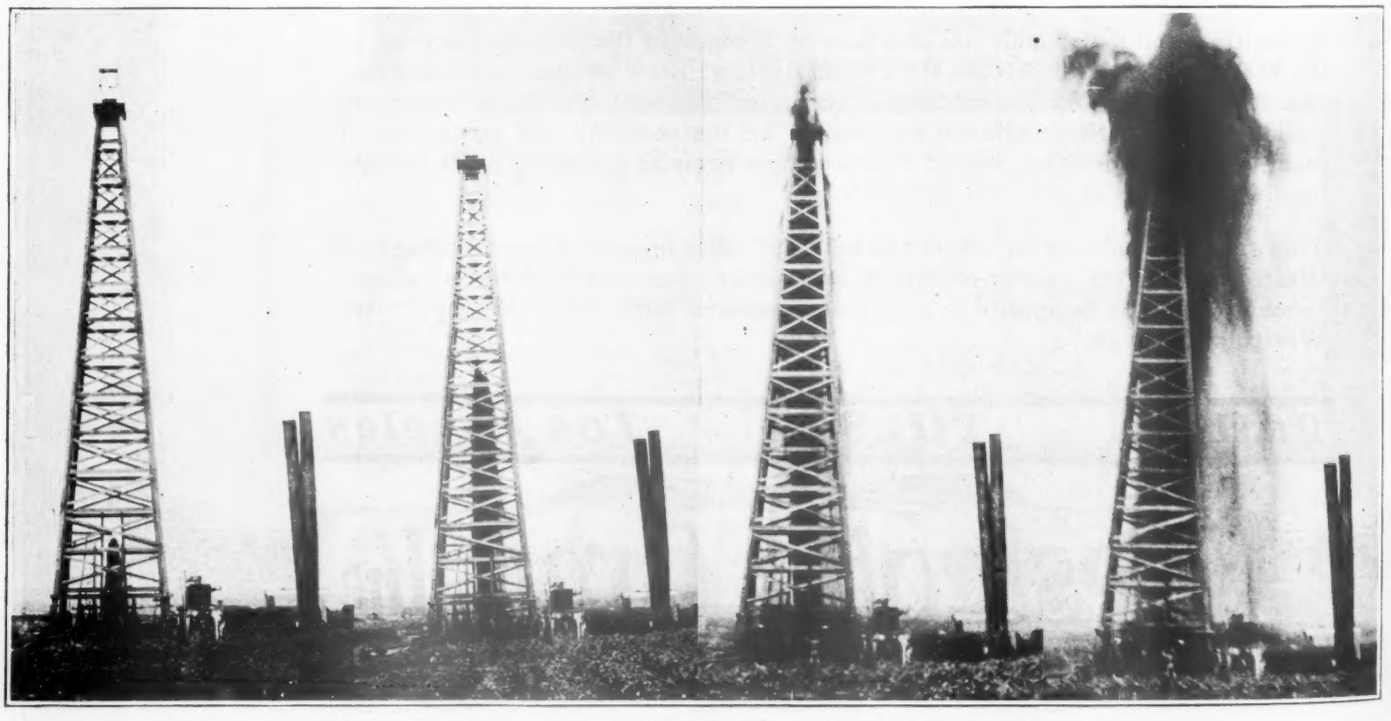
Now for the application of rotary to drilling gas wells. The most important point from now on is to keep ahead of trouble, for there is nothing meaner or more expensive in a gas field than a wild gasser, particularly one that "craters." Some samples of the latter have blown out craters that engulfed the derrick and boilers, proceeded to blow out in water wells and crevices in a radius of hundreds of yards, defied control for several months and caused annoyance and untold loss of gas, money and material to the operator.

Enormous craters and cave-ins were not uncommon in the Smackover Field but most of these were probably due to the after effects of producing gas rather than while drilling.

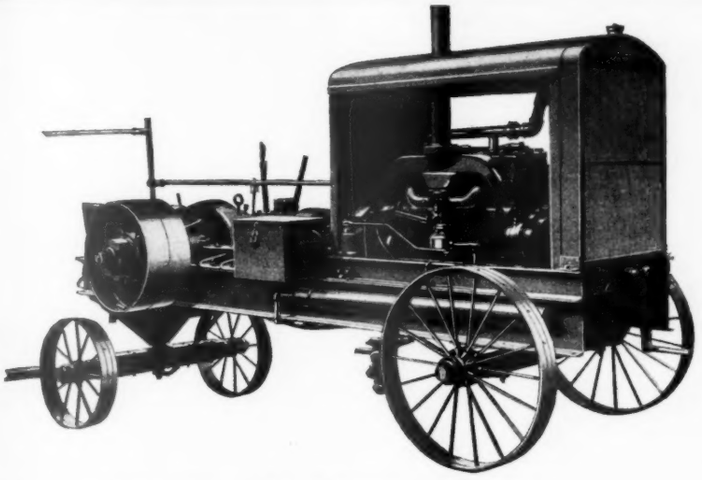
Surface Casing and Gas Strings

The best means to keep a step ahead of these cratering blowouts is to set sufficient surface casing and to carry the rotary drilling mud with a weight and density greater in hydrostatic head than the rock pressures of gas sands to be encountered. A safe minimum of surface casing would be about 100 feet cemented from bottom to top for wells down to 1,400 feet, or 200 feet for deeper wells with longer strings, dependent upon the nature of formations and depth of shallow water sands.

In most cases of rotary drilling this surface casing is the only string besides the main or gas string and the assurance afforded against damage from blowouts makes it an economic necessity. In the event of a blowout before the gas string is set, a pump or lubricator can be connected to the surface casing and the gas killed; also a generous surface casing is useful where gas blows through a hole caused by pressure or corrosion in the gas string. The size of surface casing depends on the size of gas string;



Four stages of a gas well coming in—the rotary mud is heard far and wide



Complete, Ready Mounted

Cost Slashing Power

For Gas and Oil Well Drilling and Cleaning Out

This efficient drilling Unit effects economies in production costs never before approached. It is adaptable to either Rotary or Cable Tool rigs and ably meets all situations.

The Young Drilling Engine is ready mounted, requiring the foundation timbers, and can be set up for work in Less Than Two Hours. The all iron truck equipment speeds up moving.

A heavy duty Four Cycle Hercules Motor supplies ample—and dependable—power with either gas or gasoline. There is a flexibility and "get away" not obtainable in single cylinder engines. The fuel economy is truly amazing and the cooling system requires very little water, making this Unit also ideally suited to Wildcat Work.

A Low Speed Gear is an exclusive Young Feature of great value on a fishing job when it is necessary to pull two or three strings of tools, or when necessary to start a heavy string of casing, tubing or packer. The speed on reverse is the same as on high gear.

A remarkable record of reliable and cost reducing service—both in this country and in foreign countries—is back of Young equipment. Experienced engine users recognize in the construction specification those qualities which assure reliable performance and a minimum of maintenance expense. Our Bulletin J5 will be interesting to every Driller or Operator. Gladly sent—wherever you say.

YOUNG ENGINES

Also Gas Boosters, Pulling Machines, Power Units and Well Testers

Mfg. by

Young Engine Corporation

Canton, Ohio

Western Representative

H. A. LAURENCE, 2507 Commerce St., Dallas, Texas

Quality Built in Every Detail

Setting

The Young Drilling Engine sets lengthwise with the belt house requiring only a narrow grade. For short time set-ups an engine house is unnecessary as engine is self protected against weather. Housing dimensions only 12x16 feet.

A Complete Unit

Heavy Duty Four Cycle Hercules Motor, assembled with radiator, transmission, clutch, shaft, power take-off, forge blower, and emery wheel, on a heavy smooth base steel frame, mounted on an all iron truck. It can be furnished without truck mounting if desired.

Large Belt Pulley

A large belt pulley, extra heavy split type, is used eliminating the trouble from a tight belt which happens with a small pulley. Any size pulley from 20″ to 30″ in diameter and 13″ to 16″ face can be furnished. Sprockets to drive Rotary draw works can be furnished in place of belt pulley. Belt pulley is on the left hand side and is overhung. There are no bearings to interfere with putting on belt or chain.

Exclusive Power Take-off Design

Power take-off construction is similar to a full floating rear axle drive. The shaft turns on bearings inside a stationary sleeve which serves as the hub for belt pulley. Pulley (or chain sprocket) and shaft are connected at outer end. Thus the full belt load is carried on the stationary sleeve, the shaft being fully protected from such strain.

Transmission

Heavy cut gears of alloy steel, heat treated, and running in oil, are used. Bearings are large and of genuine Babbitt in cast iron shells, easily renewed. The Main Shaft is further supported by Timken Tapered Roller Bearings.

Withdrawing Type Reverse Pinion

Reverse pinion may be withdrawn from contact with power take-off bevel gear drive in a few seconds. This eliminates wear on reverse gear during the many hours when forward gears only are used.

Send for Bulletin J5
It is Profitable Reading

Young Engine Corp., Canton, Ohio

Please mail a copy of your bulletin J5

_____

_____

_____

_____

O.G.J.-6

15½-inch surface casing for 10-inch gas string used in wells not deeper than 1,400 feet where the collapsing strength safety factor of 10-inch lapweld 40-pound casing is 2 feet; 12½-inch or 13⅜-inch surface casing for 8¼-inch gas string used in wells down to 2,600 feet for 32-pound seamless, and 3,300 feet for 8¼-inch 36-pound seamless. The safety factor should be 2½ feet or more when possible. Smaller size gas strings can be run with higher safety factors but the larger the diameter of gas string the larger will be the area of gas sand exposed with a consequent greater volume to the gas well. As this one gas string combines the functions of holding back the salt water outside the casing above the gas sands and withstanding the internal gas pressure, it is highly important that good casing be used and generously cemented. Seamless casing is recommended for the deeper wells, as its collapsing strength is about 20 per cent greater than lapweld. See Table No. 1 for collapsing strengths.

TABLE NO. 1—COLLAPSING PRESSURES OF CASING

Size Inches	Weight per foot with collars Pounds	Actual outside diameter Inches	Actual inside diameter Inches	Thickness Inches	Collapsing pressure per sq. in. Pounds	Equivalent Water col. with safety column factor of 2½ Feet	Water col. with safety factor of 2½ Feet
4½	13	5.000	4.506	.247	2,900	6,680	2,675
5 3/16	17	5.500	4.892	.304	3,400	7,840	3,135
6¼	24	6.625	5.921	.352	3,220	7,420	2,970
6⅝	20	7.000	6.456	.272	1,980	4,560	1,825
6⅝	24	7.000	6.336	.332	2,730	6,290	2,512
8¼	28	8.625	8.017	.304	1,670	3,850	1,540
8¼	32	8.625	7.921	.352	2,150	4,950	1,980
8¼	36	8.625	7.825	.400	2,600	6,000	2,424
10	40	10.750	10.054	.348	1,420	3,270	1,308
12½	50	13.000	12.282	.359	1,010	2,330	932
15½	70	16.000	15.198	.401	790	1,820	728

(Add 20 per cent to the above collapsing pressures for seamless casing.)

Size of Holes Drilled

As our well is to be, say, about 2,500 feet deep and we are going to use 8¼-inch, 32-pound seamless casing for the gas string, we begin with a 17-inch hole and drill to the point selected for the 12½-inch surface casing, then a 11-inch hole to the shoulder for the 8¼-inch and a 7⅞-inch hole to penetrate the gas sand.

For 15½-inch casing, a 20-inch hole is drilled; for 10-inch a 14-inch hole; for 6⅝-inch a 9-inch hole; for 5⅞-inch a 7⅞-inch hole.

Identifying Formations, Coring

While making hole the driller identifies the formations by watching the combined actions of the speed of penetration, pressure or laboring of circulating pump and vibrations transmitted by the drill pipe from the rotating bit to the Kelly. Formations generally encountered and their reactions on the drill stem and pumps, using a fish tail bit are:

Formation	Action of Drill Stem	Penetration
Hard lime or shell	Violent jumps, vertical and horizontal.	Very slow, if any.
Sandy lime	Jumps.	Slow.
Hard sand	Jumps.	Fair.
Soft sand	Very slight jumps.	Good.
Sandy shale	Very slight jumps.	Fair.
Hard shale	Free.	Fast.
Soft shale	Free.	Fair.
Sticky clay or "sticky shale"	Free but slows up every few feet on account of clay balling up on bit.	
Gumbo	Is tough and "rubbery"; balls up every few feet on bit.	Slow.

As a check-up when looking for a sand, cuttings of the formation made by the drill bit are caught from the circulating mud on its way to the settling pit. When sand is found in cuttings it is in very small particles or in grains and having been washed around in thin mud while being pumped out, usually are not a good indication in the case of a gas sand. Oil sands show better in cuttings.

The reactions on the drill stem and pumps and cuttings are merely indicators. Coring brings to the surface a sample of the formation in its original state. Either a single or double tube core barrel is used. The former is usually made of a piece of old drill stem about 6 feet long with threads on one end and saw teeth on the other, and two circulating holes about a foot from the top. With this barrel only a short core up to a foot long can be taken, but it is reliable and economical. Double tube core barrels are more complicated but have the double advantage of taking cores up to several feet long and at the same time drilling the hole full gauge or the desired size of a rat hole.

The expense of coring and the reliability of the core for identification purposes justify keeping them catalogued for future reference in following up a structure.

Use of Rotary Sand Tester

Within the past year the Halliburton rotary sand tester began existence, was tried out and found practical. Whenever it is desired to attempt a test of a sand without going to the expense of running a string of casing, the hole is reduced at or near the top of sand and the desired penetration made in the sand with a small bit. This leaves a shoulder above the sand.

On the outside of the tester is a conical shaped packer which is small enough on bottom to enter the reduced hole but larger on top than the shoulder. Inside the tester is a stop cock operated by gears. This stop cock is closed, the tester attached to the bottom of drill pipe, lowered in hole and set down on the shoulder. This contact with the shoulder holds the bottom part of tester rigid and by putting chain tongs on the drill pipe at the floor and turning it a quarter turn to the right the top part of the tester turns and by means of the gears, open the stop cock. As the inside of the drill stem is clear the gas, if in the sand, will go through it and show at the top.

With a core showing the sand in its original state and indicating its content, this tester is valuable to back up the core with an indicator of the quantity of gas in the sand.

Before the tester is withdrawn, and to prevent a sudden rush of fluid around the bottom of the tester into the drill pipe, the stop cock is closed by turning the drill stem a quarter turn to the left. In testing a water or oil sand a sample of fluid is brought to the surface.

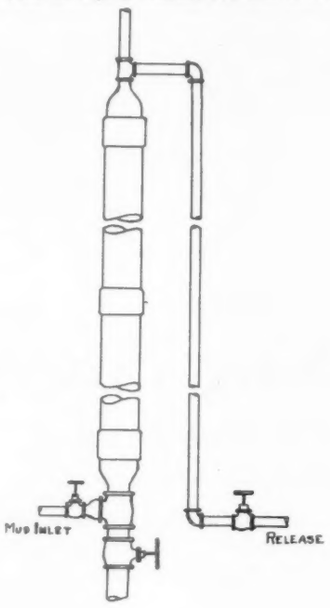
Finding Casing Point

The fact that just one string of casing acts to exclude waters on the outside and controls the gas on the inside, it becomes very important just where this casing is set. This is where the human element must strain a little. A good practice is to rat-hole ahead by putting on a smaller bit at some point above where pay is expected. This leaves a shoulder which can be reamed down later to the casing point. Generous use is made of the core barrel and the driller cautiously feels his way. Some gas sands are very elusive, some are soft, some broken, some in thin streaks alternately shale and sand.

Our caution has been rewarded and our driller gets a core of gas sand. Casing is run and cemented on the sand or on a shell immediately above it.

Method of Cementing Casing

The casing is cemented by hanging it about 2 feet above the shoulder; putting in the top of casing a wood plug about 3 feet long and with a circular disc on each end; pumping the cement in on top of the plug which forces it down; then when the cement is in the casing, a second wood plug is inserted and rotary mud pumped in which forces the two plugs with the cement between them down the casing. The amount of cement required to fill the annular space between casing and wall of hole is given in Table No. 2. The first plug reaches the bottom of the casing, stops, the cement by-passes it and follows the circulation up behind the pipe until the top plug reaches the bottom plug and stops. Since the top of this plug is the full size of inside of casing and is above the casing shoe, the rotary mud above it cannot pass which strains and shuts down the pump. A good practice is to leave about 10 feet of cement in the casing which is done by stopping the second plug at the desired place, determined on the steel measuring line that runs through a stuffing box and follows



LUBRICATOR FOR KILLING GAS WELLS.

on top of second plug on its way down the hole. The casing is set down on the shoulder, the measuring line withdrawn, valve closed on top of casing and the well shut down for cement to set.

Besides being reinforced, casing generously cemented is better able to withstand the rigors of corrosive waters on its exterior, and gas would be less likely to dissipate through leaky casing. By

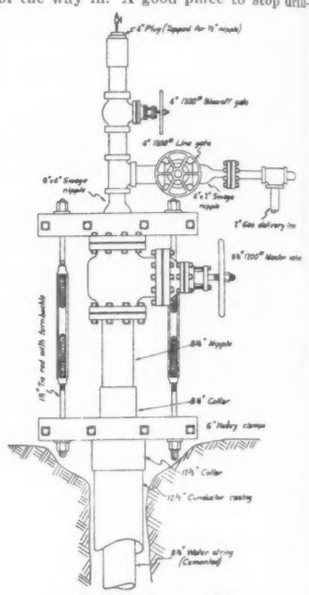
Action of Pump	
Free.	
Free.	
Free.	
Free.	
A little slower than sand.	
A little slower than sand.	
Medium labor.	
Labors and shuts down every few feet account of clay balling up on bit.	
Labors and shut down every few feet.	

the addition of a setting accelerator like Konset, Setfast, Hardenite, etc., to the cement a saving of shut-down time is effected and the cement plugs in casing jobs can be drilled in 72 hours with confidence that the cement has set.

There are other methods of cementing casing, but the two-plug method is most generally used.

Drilling In of Single Gas Sands

There are two general conditions met with in gas sands: First is a gas sand which is alone, second is a gas zone which consists of a series of sands separated by layers of shales, etc. The former is the easier drilled in, but requires constant watching for salt water. The writer believes in not drilling through such a sand, and that the most effective producing part of a lone gas sand is the first few feet. A curve struck with amount of gas as ordinate, and feet of penetration as abcissae, would show a high volume per foot at first, a slight bend at about half way and a sharp bend about two-thirds of the way in. A good place to stop drilling is at or just before this sharp bend. With cable tools, the usual practice has been to drill in the sand until the gas delivery per foot of hole declines appreciably. After leaving cable tools, the first two gas wells drilled by rotary under the supervision of the writer were drilled in dry, that is, without rotary mud. In one of these wells, on bailing to test casing set right on the sand, we had 3,000,000 cubic feet of gas. With plenty of clearance between the 6-inch drill stem and 10-inch casing we ran in a 9-inch bit and, replace it with a sand line and bailer, or run in just ahead of the draw works a chain-driven bailing reel. We bail the hole dry to test the casing shut-off. If the casing is set on a real good gas sand, the bailing process is shortened by part of the mud being blown out. After allowing the well to set several hours, or until we are confident that the shut-off will hold, the hole is again filled up with rotary mud and we are ready for the next straining point, drilling in. If we do not have a shut-off, it must be recemented. That is the reason for not making any new hole while drilling plugs before the casing shut-off is tested. To make hole would tend to throw confusion into the effort to determine the source of water.



A Christmas Tree

TABLE NO. 2

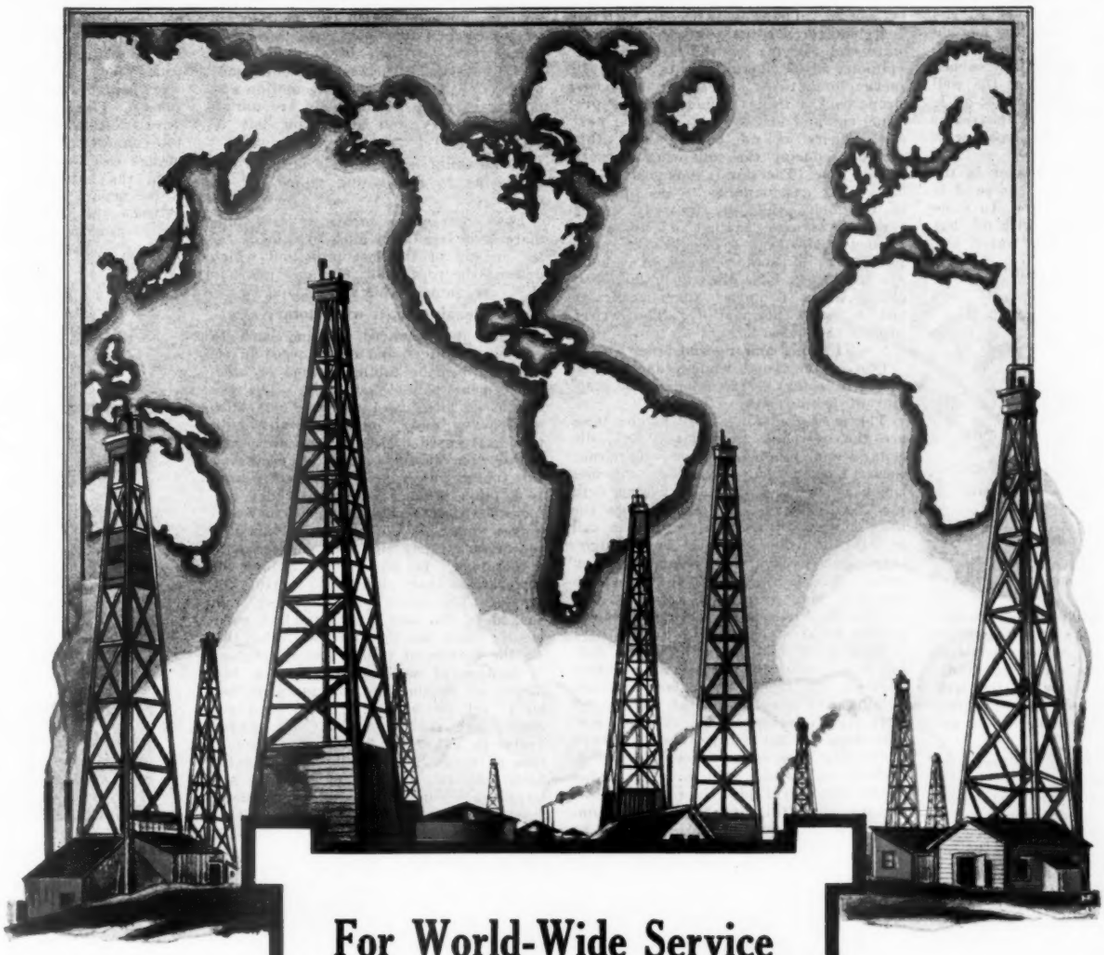
Table showing number of linear feet filled by one sack of cement, when set, in the annular space outside various strings of casing in various sizes of holes. (One sack of "dry" cement contains approximately 1 cu. ft. One sack of "set" cement contains approximately 1.10 cu. ft.)

Size of casing in Inches Nominal diam.	Outside diam.	Diameter of Hole to Be Cemented (in inches) 6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
4½	5	18.4	8.4	5.2	3.6	2.7	2.1	...	...	...	...	...	...	...	...	...
5 3/16	5½	35.1	10.8	6.0	4.0	2.9	2.2	1.8	1.5	...	...	...	...	...	...	...
6¼	6⅝	...	...	10.0	5.4	3.6	2.6	2.0	1.6	1.3	...	...	...	...	...	...
6⅝	7	...	...	13.4	6.3	4.0	2.8	2.1	1.7	1.4	1.1	...	...	...	...	...
8⅛	8⅝	...	...	...	30.5	7.9	4.3	2.9	2.1	1.7	1.3	...	...	...	...	...
10	10¾	...	...	...	...	...	37.0	7.1	3.8	2.5	1.8	1.4	...	...	...	...
12½	13	...	...	...	...	...	...	...	...	7.5	3.6	2.3	1.7	1.3	1.1	...
15½	16	...	...	...	...	...	...	...	...	...	...	...	6.1	3.0	1.9	1.4

Drilling of Plugs, Testing Casing

A master gate should be on hand at all times during drilling of gas wells, and now that we have drilled the cement plugs and just touched the top of the formation underlying the casing, we remove the drill stem, put on the master gate, remove the drilling line from the drum and without mud, drilled in the well gradually, with clouds of sand blowing from the hole and reaching hundreds of yards. When the gas failed to increase proportionately with the amount of hole drilled, we stoped at 10 feet in and had 21,000,000 cubic feet of dry gas.

That was an attempt to duplicate the



For World-Wide Service

For well over a quarter of a century HOUGH PUMPING SPECIALTIES have been making enviable records—the names of Steelex, Bronzex, Repelex, Lewis, Duo, Hough (all brand names) have stood for the most economical of all balls and seats, working barrels, valves and pumps. A dealer organization that blankets the entire oil industry handle HOUGH products and guarantee them fully. They are used and respected in every known oil field. Every product engineered and made of the best of materials. Buy "Products that cut down your underground overhead."

THE CHARLES N. HOUGH MFG. CO., Franklin, Penna.

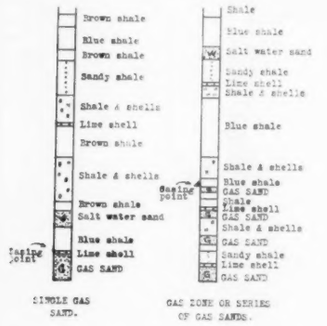
W. TARKINGTON, Sales Representative
1724 Ruth St., Houston, Texas

C. O. SHUMAKER, Sales Representative
1143 South Xanthus St., Tulsa, Okla.

Products That Cut Down Your Underground Overhead

drilling-in feature of cable tools. Another well was drilled that way, but on account of the additional fire hazard, and the fact that the crew has to work in gas while pulling the drill stem, this method was discontinued. To stop when maximum delivery per foot of hole is reached will lengthen the dry period of the well and when water does show, a shut-off is more readily accomplished by having a firm base for driving lead wool with cleaning-out tools.

Particular care should be taken in the drilling in of gas well when the sand is down a ways on the structure. In some gas sands, the gas is edged with oil, but most likely there will be salt water.



SINGLE GAS SAND. GAS ZONE OR SERIES OF GAS SANDS.

Producing from single gas sands is better practice for the sake of ultimate recovery and control of water problems than producing from a series of sands. In the former practice, when the well ceases to produce or goes to salt water, it can be deepened and casing set on another gas sand.

Drilling In in Gas Zones or Series of Sands

Sometimes a wildcat finds a series of gas sands or several sands superimposed with layers of shale or limestone between them. Sometimes this zone is several hundred feet thick. They bring in a big gasser. The other operators who are on the job soon after the lucky strike probably go after the same sands, hence the practice is started. Long perforated liners are put in, extending from bottom of casing to bottom of hole, to hold the formations in place, the perforations allowing the gas to enter the hole.

In drilling a series of sands, it is extremely necessary to keep on the alert for water. A good way to keep a check on the series is to find one sand, bail, read the gas volume and take rock pressure, kill the gas, find the next sand, bail, etc., and repeat this to the bottom of the hole. If the open hole gets too deep to bail and test without getting a bad cave, a liner can be run, the hole reduced and a smaller liner run to bottom. Should a sand be encountered that carries salt water, the hole can be plugged back.

Series drilling lends complications to the water problem which, if not present when wells are completed, is liable to be when sufficient gas is taken from a sand to make room for encroaching edge water. One sand may go to water before another, thereby affecting the whole series, the operator not knowing just which sand is the bad boy. This leads to premature abandonments or an expensive task of trying to keep an ever present head of water off the sands.

Perforated Liners

Some operators use a liner made up of line pipe or casing with collars; some use casing welded at the joints; and some use inserted liners or casing that has threads but no collars, the thickness of the casing being divided between the female and the male end. The latter liner has a weakness at the joint and can not stand much pulling, but its smooth exterior makes it less liable to stick than collared pipe. A long perforated liner is hard to pull anyway, and there is an advantage in pulling an inserted liner in sections rather than have to pull apart a welded liner. Welding pipe at a well has a disadvantage in that welds made on the derrick floor while running liner usually are not allowed to cool. When it is run in the hole the hot weld strikes the rotary mud, affecting the toughness of the weld.

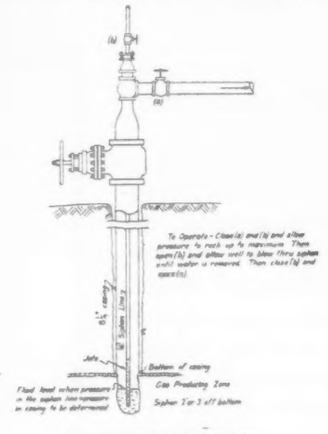
The perforations used are either round or slotted. The slots are cut with an acetylene torch a little less than ¼-inch wide and varying widths, according to opinion. One operator cuts them 16 inches long, turns the casing 4 inches, drops back 4 inches from bottom of previous cut and starts the top of the next slot. There is no doubt about this method reducing the collapsing strength of the pipe. The slot is defended on the basis that gas, tending to go upwards in the hole, will cut its way easier through cavings against a slot than against a hole, and that a hole is easily plugged by a pebble or rock. The holes are usually ⅝-inch or ¾-inch diameter, drilled about 6 inches apart vertically and 4 inches horizontally. The writer prefers the holes.

Fishing and Special Jobs

One of the worth-while economies effected by rotary is the comparative scarcity of fishing jobs.

The most commonly used fishing tools are the overshot, taps, latch jack, die collars and nipples, wash-down release spear, basket, and wall hook. Sometimes a left-hand threaded fishing drill pipe is necessary. For special jobs the tools most used are four wing fish tail or disc or roller reamer for straight reaming, expansion underreamer, casing cutter, diamond point bit for sidetracking, etc., long spiral drill collar to prevent crooked holes, perforator, whipstock, milling tools, etc.

Twisted off drill pipe causes most fishing jobs. For this purpose an overshot is used, the inside being large enough to slip over a collar of the twisted off drill pipe. Inside of the overshot several dogs or flat springs are attached which slip over collar when overshot is lowered and which grip underneath the collar when drill pipe is raised, allowing the lost drill pipe to be pulled on. Should a plain end of the drill pipe be


(a)
(b)
To Operate - Close (a) and (b) and allow pressure to rock up to maximum. Then open (b) and allow well to blow thru siphon until water is removed. Then close (a) and open (c)
6¼" casing
2" Siphon Line
Bottom of casing
Gas Producing Zone
Siphon 1' or 2' off bottom
Fluid level when pressure in the siphon line equalizes in casing to be determined

SHOWING SIPHON INSTALLATION ... WELLS

up, a joint of casing is screwed on top of the overshot to allow it to slip over the plain joint and catch the collar on the next joint. A lipped guide is attached to the bottom of overshot so that cavings can be rotated out of the way and to guide the lost drill pipe away from the wall of hole into the overshot.

Should the lost drill pipe be frozen so the overshot can not pull it, a rotary casing shoe with saw teeth on the bottom is run on the bottom of casing large enough to go over the drill stem. The casing is rotated and with circulation the shoe cuts down to the bottom of lost drill pipe. Heavy mud is then circulated to hold up the walls, the casing withdrawn and an overshot run after the drill pipe, or both the casing and drill stem pulled together.

Threaded fishing taps are run after lost bailers from which the bail has been pulled, drill pipe lost in holes too small for overshot, etc.

Baskets are sections of casing with long teeth cut in bottom. They are run in after junk pieces of metal, etc., over which the teeth are closed by rotation and weight of drill stem.

For fishing casing or liner satisfactory spears are made which can be washed down through cavings to take hold of pipe and which can be released by rotating. Cable tool trip spears with long stroke jars have been run on drill pipe, sometimes successfully but more often not. The reciprocating motion and jarring of cable fishing tools are unnatural to rotary and are better left to their original purposes.

A die collar or die nipple is often run on casing to fish casing pulled out of collars.

For sidetracking casing or drill pipe there are regular whipstocks made to set on top of the lost pipe and which deflects the rotary bit, diamond point in this case, into making a new hole.

Plugging Back with Rotary

When it is desired to plug back to exclude a water sand encountered in series drilling, the tubing method of landing cement is most suitable. The gas should be killed and the hole left filled with heavy rotary mud until all ebullition has ceased. This is very necessary. There are different ways of preparing the tubing but a very satisfactory way is to put a dozen or so one-half-inch perforations in a 2-inch tubing nipple about 3 feet long. In the bottom of this nipple drive a fairly tight wood plug about a foot long. Do not nail it through the perforations nor clinch the bottom of nipple. The wood plug will get mud soaked in the hole, swell and get sufficiently tight for the purpose. Put this on the bottom of tubing and run tubing to bottom of well, picking up a few inches of tension to straighten it but let it set on bottom. Pump into the tubing the desired amount of cement (refer to Table No. 3) mixed in proportion of about 5 gallons of water to the sack with the addition of 1 gallon setting accelerator to two sacks cement. Put on top of the cement in the tubing a wood plug about 6 feet long and 1½ inches in diameter with a disc on top made of belting the full size of inside of tubing. Pump the plug with the cement ahead of it down the tubing using rotary mud to follow it. When the long plug strikes the bottom the belt disc clogs the tubing above the perforations and shuts the pump down.

Pick up the tubing to the point where you wish to plug back and put the pump pressure on the tubing. The wood plugs will be forced out of the bottom of tubing and excess cement above the desired top of plug can be circulated out of the hole. It is advisable to let the well set a little longer than a casing, cement job as salt water is retardant to the setting of cement.

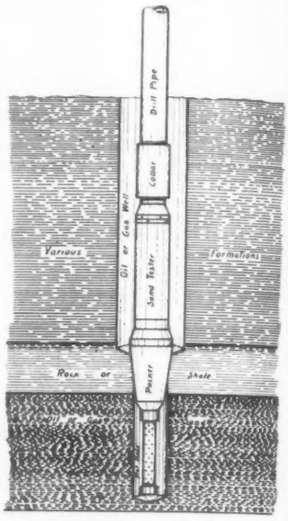
To plug back a small amount of sand to exclude bottom water the use of a good cement dump bailer is recommended; also the use of an aluminate cement which is more dense, has greater compressive strength and sets quickly. Some steel lathe cuttings or several strands of wire line with ends doubled up should be put in the bottom of hole to reinforce the cement and help to grip the walls to overcome the heaving pressure of the water when the well is bailed. When there is any great amount of water pressure it is advisable to drill clear through the sand and plug back. This will tend to eliminate the heaving pressure as the water is not underneath the plug but on the sides.

TABLE NO. 3—CAPACITY OF OPEN HOLE

Diam. of Hole, in.	Capacity per Linear foot		Height Filled by		
	Cu. Ft.	Bbls.	1 cu. ft.	1 Bbl.	1 Sack Cement
			Ft.	Ft.	Ft.
4	.09	.016	11.46	64.34	12.61
5	.14	.024	7.33	41.18	8.07
6	.20	.035	5.09	28.60	5.60
7	.27	.048	3.74	21.01	4.12
8	.35	.062	2.86	16 08	3.15
9	.44	.079	2.26	12.71	2.49
10	.55	.097	1.83	10.29	2.02
11	.66	.118	1.52	8.51	1.67
14	1.07	.196	.94	5.25	1.03
17	1 58	.281	.63	3.56	.70

Siphons

Any handling of salt water in a gas well is like a running sore to the purse of the operator, and it is urged that a shut-off be attempted if possible. Should it be impractical to do so, the use of a siphon or small tubing has been very satisfactory. Ordinarily, this is 1-inch, long-collared, buttweld tubing, 1.68 pounds per foot which is run in the well with one or more 1-inch tees or some perforations at or near bottom. The tubing is left hanging on a 4-inch bushing or stuffing box screwed into the top connection. A high pressure brass stopcock controls the flow at the top of tubing. The head of water can be blown directly from the tubing to a pit or a top connection made so that the delivery of gas can be taken through the 1-inch from the bottom of the hole and the water separated from the gas in drips between the well and meter. The latter arrangement, where practicable, lessens or eliminates the waste of gas while blowing. It is well, too, to connect up the siphon line so that in the event of



Halliburton Rotary Sand Tester

its stopping up, the pressure from the casing can be applied to the top of tubing.

In special cases one or more small jets are placed up in the 1-inch tubing at places figured to pick up or accelerate the flow of water. The size of spacing or jets is determined by considering as factors the hydrostatic head and level of the fluid to be lifted, shut-in pressure at well head, rock pressure, the difference between water level inside casing when casing is shut in at top and water level inside 1-inch tubing open to atmosphere at top. Discussion of this would be lengthy and should be the subject of a special article.

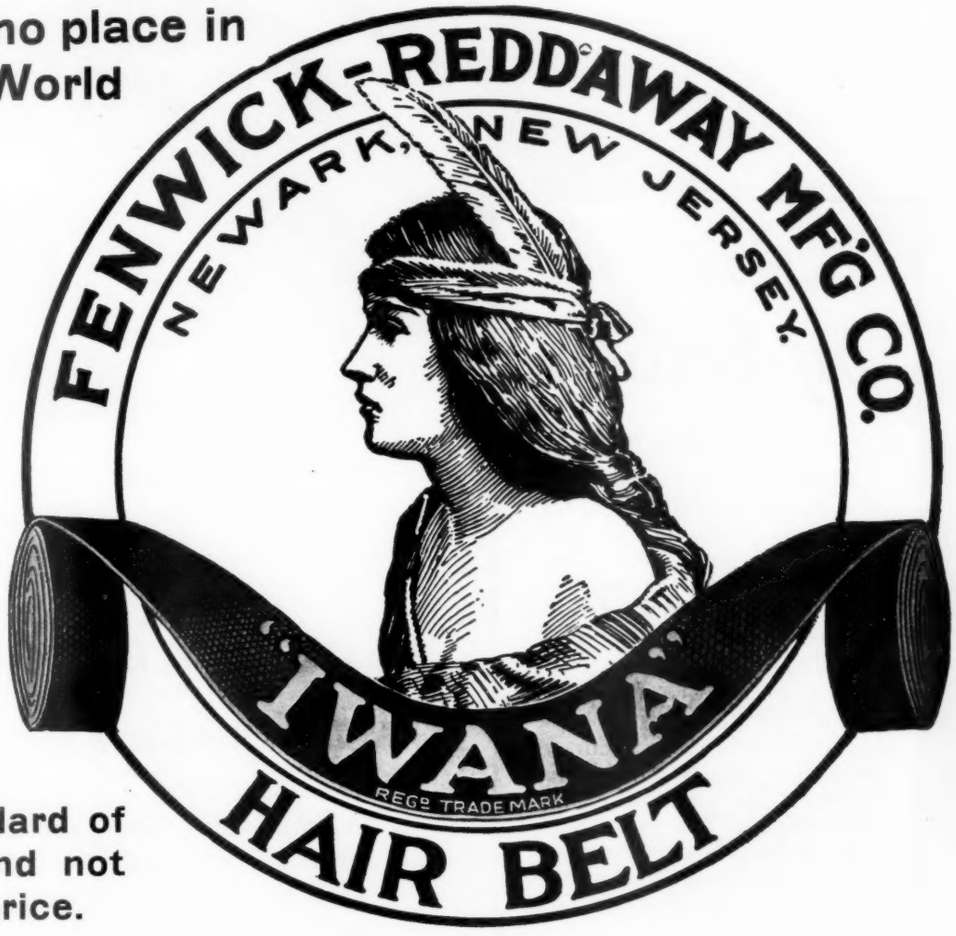
Killing Gas Wells Or "Blowouts"

When a well accidentally blows out or when it is desired to kill a well after a sand is tested during drilling of a series of gas sands two methods are used. If the well is not too large and does not build up pressure too fast, the drill pipe can be lowered to or near bottom and mud pumped in. This has been done in some wells making up to 6,000,000 cubic feet of gas with 800 pounds rock pressure. For large wells a lubricator is used. (Figure 11). A satisfactory lubricator is made of one or more joints of casing screwed together and connected by a tee and union to a nipple in the master gate. Into the tee mud is pumped until the lubricator is full. A small release gate on top of lubricator is closed and the master gate, or smaller auxiliary gate just above it, is opened. The mud, being heavier than gas, will bypass the gas and run down the sides of casing into the well. When the lubricator is empty the master or auxiliary gate

Read This Out Loud

Prejudice has no place in the Business World today.

It Is Performance and Record That Counts.



Built up to standard of highest quality and not down to meet a price.

Tulsa Representative
A. F. Campbell, Box 171

California Representative
National Supply Co. of California

DURABILITY

STRENGTH

LONG LIFE

SAVES POWER

SAVES MONEY

WORKS Under All CLIMATIC Conditions

Annou
SMITH
P I

for natural

Better pipe at better costs

A modern product made in a modern way

Smithsteel Gas Line Pipe is made by the same process as Smithsteel Couplings and Smithsteel Cracking Stills that have been such an outstanding success in the oil industry.

Smithsteel Gas Line Pipe throughout is a superior product made possible by advanced engineering thought and advanced engineering methods.

You can specify any *thinness* that you want. Due to the Smith Method of fabrication it is possible to make Smithsteel Gas Line Pipe *round* and *accurate* in *any* desired thickness.

This will permit new economies in the building of cross country lines.

Savings *by* Smith

Fewer Joints

Smithsteel Pipe is made plain end and plain end beveled for any field joint. The 30-foot lengths of Smithsteel Pipe will require only 175 joints to the mile as compared with 262 needed for the usual 20-foot lengths of pipe.

Jointing Simpler

Smithsteel Pipe is accurate in both outside and inside diameters. The wall thicknesses are uniform. The joints will butt up evenly at all points making alignment and either welding or coupling simpler and surer. Joining will therefore be quicker and easier.

The Use of Less Metal

Due to the A. O. Smith method of fabricating and the high quality steel less metal can be used in the body of the pipe.

SMITHSTEEL

ncing STEEL IPE

gas lines

4½ miles of 22 inch per day

Length up to 30 feet — fewer joints

The new pipe mill of the A. O. Smith Corporation will have a capacity of 4½ miles of pipe per day.

This is pipe of 16 to 22 inch outside diameters.

Lengths will be made *uniform* to any length specification from 10 to 30 feet.

It will be *accurate* in diameter and wall thickness. For complete information on this new and better pipe, address

A. O. SMITH CORPORATION
Oil Field Products Division
MILWAUKEE, WISCONSIN
LOS ANGELES

Smith's Method and Facilities

The A. O. Smith method of manufacture makes possible the production of pipe from 16 to 22 inches in diameter and from 10 to 30 feet in length of *uniform* lengths, diameters, and wall thicknesses.

A Modern Product

Smithsteel Pipe is a modern product in every particular. It is a modern design, made in a modern manufacturing plant, by modern methods. It follows the modern trend toward *efficiency* with *economy*.

Manufacturing Facilities

Smithsteel Pipe has behind it the great resources, engineering service, and manufacturing facilities of the A. O. Smith Corporation.

Capacity will be 4½ miles of pipe per day. The method makes increases in capacity simple if found to be needed.

Accuracy

Smithsteel Pipe is accurate in every dimension.

Each length matches the next in roundness and wall thicknesses. The ends are straight and flush

GAS LINE PIPE

is closed, the release gate opened and the process repeated until the hole is filled.

In the case of a blowout occurring between the gas string and surface casing caused by a leak or break in the former the well should be killed and a smaller string run inside and cemented or fitted with a hook wall packer to set below the leak.

Right here is the place to say that rotary mud is most valuable in a gas field for killing wild gas wells, and it should be kept free of sand or grit and available for emergencies. It is common between operators to borrow mud. Sometimes during rotary drilling "circulation is lost" which means that all the mud pumped in goes into some cavity or very porous formation. To regain circulation means to fill or seal the cavity or porous formation with a very heavy mud sometimes thickened with slaked lime or cement, or with a regular cementing job. In the case of wild gassers or blowouts between casings, etc., when a real heavy mud is necessary to overcome real high pressures, the addition of chemicals like barytes and iron oxide will raise it from 10 or 11 pounds to the gallon to 15 pounds or higher. In some cases cottonseed hulls are added as a filler.

Connecting Up Gas Wells

Properly connecting up a gas well is very important. Under high pressures a leak soon begins to grow larger by cutting its way through poor connections. Connections should be of sufficient bodily weight to withstand a manufacturer's test of twice the rock pressure. A gate is subject to severe pressure on its discs, which are forced against the seats, making it difficult to open. It is not uncommon to see a group of men with crowbars "raring" on a master gate to open it and in cases of inferior material or gates of too low test pressure there have been cases of stems twisting off. That means that the gate cannot be opened and must be unscrewed from the casing under pressure—wow! A good time to test your running prowess.

For a master gate, in cases of large volume and high pressure, it is a good idea to have what are called drilling valves, the threads being for the size casing in the gas string but with a body of the next size larger. In this type of valve the seats are larger than the openings, which will allow the bailer, gas sand, or rocks that might blow through it to pass without touching and damaging the seats. In ordinary valves the seats are a little smaller than the openings for casing and likely to be easily damaged. As salt water is often associated with gas wells, a noncorrosive tough metal is recommended for valve stems.

The smaller connections which complete the "Christmas Tree" are of the same rated pressure tests as the master gate and usually consist of a blow-off gate on top and one or more side gates for delivery. Some operators put a small auxiliary gate just above the master gate, as it opens and closes more easily than the master gate.

This subject is included because the obligation of rotary does not cease until the Christmas tree is connected up.

Finale

What happened to that mythical gas well we started drilling? By gosh! she's about ready to bring in. We almost lost her in the shuffle of popping off about Christmas trees, etc. Let's get the master gate on and bail her! Maybe it will be a whopper—maybe not. Who knows? This uncertainty is what adds zip to the game of finding gas—"nothing venture, nothing have!"

Wow! That much-talked-about rotary mud is heaved high and wide over the crown blocks, and she's a good dry gasser. Shut her in, boys!

A deafened crew of roughnecks are flushing the mud off the equipment and another cycle is completed in rotary's quest for gas.

HARDER TO GET DOWN THAN UP

Owing to precipitous grades in West Virginia it is often necessary to carry material on a round-about road to reach the crest of a mountain and then "snake" the material down the mountain side to the gas well location. The picture shows a boiler being "snaked" down hill to a location for a well.

CONSTRUCTING PIPE LINE OVER MOUNTAIN IS MAN-SIZED JOB

By Wallace B. Gribble

In considering the location of a route for a pipe line, many things must necessarily be given full consideration. The location of the line between two points should be as straight a line as good pipe lining will admit. Follow the crest of the hills and mountains to avoid the land slides which are so prevalent in mountainous territory. Land slides are the great enemies of pipe line maintenance and operation. When necessary to cross from one range of hills or mountains to another, the descent and ascent shall traverse projecting points, whose crests are composed of sand and stone, as free from water spouts as possible. River crossings, if possible, should be made in a body of still water, free from riffles or rapid current.

Moving the pipe from the shipping point on the railroad to the pipe line right of way is accomplished by horses, cattle and wagons drawing a few joints of the pipe, sometimes as far as 40 miles, through rough and rugged country, over roads not accessible to travel by the usual conveyances. Following these roads or trails from the railroads with the pipe, there are few places where it is possible for teams of horses or cattle to ascend the hill or mountain with a load of pipe to the right of way. An accessible place must be sought where it is possible for teams to draw their load to the crest of the hill or mountain. Such passes are not frequent in mountainous territory. After the teams are obliged to draw the heavy loads many miles around to find a pass that will admit them to the top of the mountain, large sections of the pipe line are moved to the mountain top through this one pass, then along the crest of the mountain as far as it is possible to string the pipe. Sometimes, in some sections, an accessible pass to the mountain top does not exist, and in such cases the horses or cattle are worked up the mountain side (unattached to any load or conveyance) to a point commonly called a bench against the mountain side, where the horses or cattle can draw a line along the mountain side on the bench. The wagons and pipe in single joints are drawn up the mountain to this bench by means of lines and blocks, then the horses or cattle are moved further up the mountain to another bench; another haul is made again by the line and block and repeated until the pipe is moved to the top of this mountain range.

Going Down a Mountain

In making a descent along the side of the mountain, the pipe must first be hauled to the top of the mountain through the pass or by means of the lines and blocks, as heretofore described, then lowered by separate joints by lines, commonly called snubbing lines. As the joint of pipe is lowered to its place, it must be securely anchored or fastened in such a way as to safely hold it in place until lowered into a ditch.

Where we use the pass to reach the top of the mountain, it is very frequent that such pass is very rough and steep, making it necessary to double our horsepower to the loads. We have conditions where it required 16 head of horses or cattle to move a single load of pipe over one of such passes. In much of the mountain territory where such pipe lines are constructed, few people reside, making it impossible to secure accommodations of food and shelter for those engaged in this construction. To care for those on this work, the operating company must provide boarding and sleeping camps along such pipe lines. These outfits consist principally of camping tents, provided with suitable cooking equipment, dishes, etc., dining room, sleeping rooms equipped with cots for beds, and the necessary bedding. Camps are moved from point to point as the work progresses. Supplies for such camps must be moved from the most convenient railroad shipping point through the territory heretofore described. On an extensive pipe line construction job, about 350 men are accommodated at these camps, and when necessary, more than one camp is operated along the line. Great care must be taken to prevent an outbreak of some contagious disease among the men housed in camps. They are especially susceptible to typhoid.

When the pipe is strung on the right of way, a strip along the line is cleared preparatory to ditching. A large ditch is dug along side the pipe by men with picks and shovels where no stone is encountered, but where stone is found it must be drilled and shot up. The loose stone is then removed by hand and placed along side the ditch. On large jobs the drilling of stone is done by compressed air provided by the necessary portable machinery, that can be moved along as the work progresses. Where the ditches are made against the mountain side, the dirt and stone moved must be carefully placed by the side of the line, and a suitable crib constructed of lumber or poles to hold and retain the stone at the point where it has been removed, as it is necessary to hold and retain this for filling in on the pipe after it is laid in the ditch. Great care must be taken by those working on the ditch to carefully and safely place each small stone removed from the ditch in a secure place on the side to prevent it from rolling down the mountain. In shooting stone, blasting powder is used and it must be moved from the shipping point on the railroad to the pipe line. Shots are usually discharged by electric batteries.

After the ditch is completed, the joints of pipe are picked up by men in the laying gang, and put on skids or horses placed over the ditch. The joints are then coupled together for a long string, then carefully lowered to the bottom of the ditch. All of this pipe line weight must be borne by the strength of the men engaged, as the mountains are so rough and steep it is impossible to use machinery to lift this pipe. Against the mountain side the men work under very great difficulties. It is almost impossible for a workman to retain safe foothold while engaged in making the ditch, picking up a joint of heavy pipe and placing it in the ditch. Should a workman lose his foothold, he may fall and slide hundreds of feet down the mountain side.

In constructing a pipe line through hilly and mountainous territory, many over and under bends are necessary. All over bend ditches are made very deep, and under bends very shallow, but these conditions cannot be wholly cared for by ditching. They are further provided for by bending the joint or joints of pipe. This is accomplished by heating the joint of pipe to a temperature that the necessary bend can be made by the force of a chain vise. It requires a great deal of skill to make such bends and not buckle the pipe.

Ditches for pipe lines must be of a depth sufficient to hold the pipe and provide space for sufficient covering or filling to add weight to the pipe to hold it in place when a high pressure is placed in the line. The cover or filling in the ditch is provided by the dirt and stone removed from the ditch. All such dirt and stone is placed in the ditch and heaped or ridged carefully over the line.

In laying pipe lines up or down steep mountain sides where there is solid stone, large U bolts are placed around the pipe and anchored with cement to the solid stone to securely hold the pipe line in place.

In filling in on the pipe line, many resulting conditions must be anticipated and provided against. Where the earth has been broken against a mountain side, it picks up and provides a chute for the water drain, which, in a course of time, would wash away all of the cover on the line. This must be provided against by building breakers of stone and cement in the ditch on the pipe. In most cases these extend from the bottom to the top of the mountain.

In constructing a river crossing, a ditch must be dredged through the bottom of the river to hold the pipe securely, and below any danger of washing and breaking. This also must be done in the crossing of public highways and railroads.

READY FOR BACK FILL

Stretch of a natural gas line in ditch ready to be covered with dirt and stone.

WILLIAMS BROTHERS INC.

Engineers - Contractors
Oil and Gas
Pipe Line Construction

302 S. CHEYENNE TULSA, OKLA.

Continuous Satisfactory Service to the Producer and Consumer of Natural Gas

Union Gas Corporation

OPERATING IN KANSAS

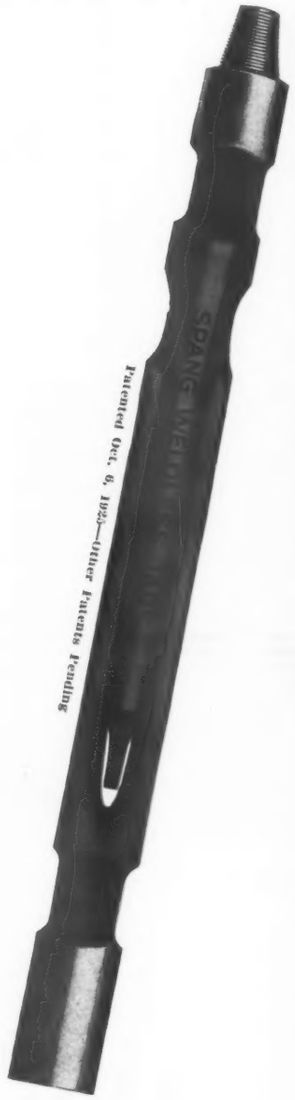
Osage Gas Producing Company

OPERATING IN OKLAHOMA

Independence, Kansas

EXPERIENCE

Thirty years experience in making the better kind of oil tools, and up-to-date factory, a patented process, special Alloy Steel and proper heat treatment are all combined in each set of SPANG WELDLESS JARS. That's why they dominate their field.



SPANG AND COMPANY
BUTLER PENNA.

Sold by All Leading Supply Houses

Patented Oct. 6, 1925—Other Patents Pending

Drilling of Deepest Cable Tool Well

Unusual Fishing Jobs Explained. Novel Method of Determining Slope of Hole. Workers Had to Use Gas Masks

By E. W. Williamson and Eugene Siggins

The theory and practice of deep well drilling is not unlike the theory and practice of ordinary well drilling. Great care must be exercised in selecting locations. One of the main features is accessibility, as larger machinery, tools, more fuel, etc., are required. Most of the deep wells in the Appalachian Field have required from one to seven years for completion. Delays have been numerous, due to various causes, a few of the more vital of these will be dwelt upon in this article. J. French Robinson has written an article on the "Appalachian Oil and Gas Field Geology," published in this issue, in which he has listed most of the deep wells and shown their approximate location.

After making a thorough and comparative study of the available data on deep well drilling in this section, we have found that the difficulties encountered, are, in general, very similar over the entire Appalachian Field. For this reason much of the data and description in this article will be confined to the Peoples Natural Gas Co.'s No. 1,842, which was drilled to a depth of 7,756 feet with cable tools and was until recently the deepest well in the world. This well is located along the Lincoln Highway, about 4 miles west of Ligonier, near McCance, Westmoreland County, Pennsylvania. Geologically, it is located near the apex of the Chestnut Ridge Anticline.

Preparation for Drilling

After the stake has been driven for the location of the well, the surrounding territory is cleaned off, and good-size storage yard is provided. Prior to the building of the rig, a cellar is dug, usually about 8 feet square and to a depth of several feet, or until a solid rock base is encountered. A ditch is provided on the lower side of the cellar, so as to guarantee thorough drainage; the object of the cellar being to provide a suitable place for the rings and slips which support the separate strings of casing that are to be placed in the well. The cellar also provides ample space to allow the installation of gates in case a large flow of gas is encountered.

The derrick used in drilling deep wells is similar to that used with the standard rig, with the exception that it is made larger and heavier throughout.

The rig is 94 feet high, 26 feet square at the base and about 5 feet square at the top. It is equipped with a crow's nest top 14 feet square, which is to provide space for men to work with safety when handling heavy material.

The steel crown which is to support the crown pulley is made extra strong by using four heavy 12-inch I-beams. Attached to these beams are five pulleys which are used to complete the set of blocks used in lowering the heavy strings of pipe into the well. The legs of the derrick are made up of 2 by 12 inches of 16 feet pieces, placed three ply, reinforced with 8 by 8-inch timbers, 16 feet long, running the entire height of the derrick. The girts are made of 2 by 12-inch pieces, double ply, braced with 2 by 10-inch material. The sway braces are 2 by 10-inch pieces, covering three sections of the derrick. All of the lumber used in the construction of this rig is a first-grade white oak, and contains approximately 6,000 feet of lumber.

The band wheel is 13 feet in diameter with a 7½-inch crankshaft. It is equipped with a four-grooved 7-foot tug wheel. The bull wheels are 8 feet in diameter and have a 27-inch shaft. Attached to the bull wheel near either end are two brake wheels with 16-inch steel brake bands. The walking beam consists of a piece of timber 24 by 32-inch by 28 feet and is of the very best quality of white oak. Some deep wells are equipped with one 80 horsepower boiler, while others have two or more small boilers, depending upon the local conditions. A 30 to 70 horsepower engine is used in most of the deep drilling in the Appalachian Field.

Standard Drilling Tools

Standard drilling tools are used throughout with the exception of a few special tools; some of which are the jar-type bailer; the work of which will be explained later.

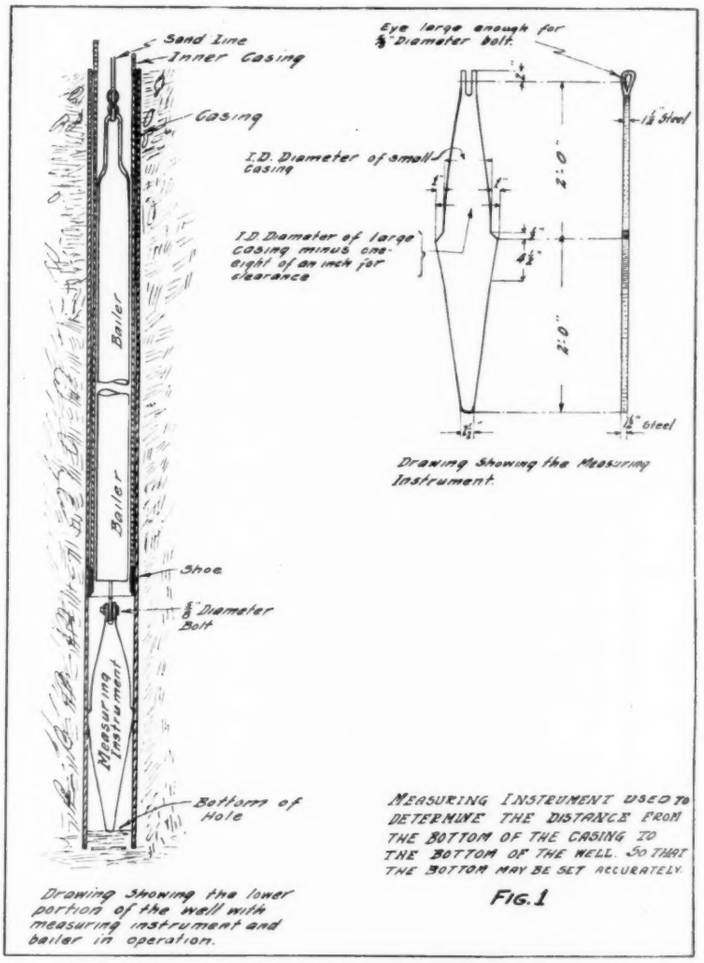
The jar-type bailer is the usual bailer fitted with a set of small jars made in connection with the bail which has been found very helpful in jarring the bailer loose when "stuck" by cavings or crooked hole.

The dump bailer is constructed with a plug valve attached to a rod in which a link with about 12-inch drop is constructed. The rod is attached to the bail.

The bailer is fitted with a latch and when the bailer is set down, engages the bailer tube and, when raised, lifts the tube off the plug valve, giving the bottom of the bailer a full opening.

As drilling continues, conditions arise requiring different types of tools not commonly used. These tools are designed and made as the emergency requires.

Most of the deep wells are drilled with seven-eighths-inch steel cable to a depth of perhaps 6,000 feet. From this point, a depth of 7,756 feet. After drilling to a considerable depth, it was found that both the cable and the casing were being damaged by the friction caused by the cable upon the casing. This was properly overcome by keeping the drilling cable thoroughly greased and lubricated. The grease is applied to the drilling cable and protects both it and the casing.


Sand Line
Inner Casing
Casing
Bailer
Bailer
Shoe
⅝" Diameter Bolt
Measuring Instrument
Bottom of Hole
Eye large enough for ⅝" Diameter bolt
1½" Steel
I.D. Diameter of small casing
I.D. Diameter of large casing minus one-eight of an inch for clearance
2'-0"
2'-0"
¾" Steel
Drawing Showing the Measuring Instrument.
MEASURING INSTRUMENT USED TO DETERMINE THE DISTANCE FROM THE BOTTOM OF THE CASING TO THE BOTTOM OF THE WELL. SO THAT THE BOTTOM MAY BE SET ACCURATELY.
FIG. 1

Drawing Showing the lower portion of the well with measuring instrument and bailer in operation.

Starting the Hole

A deep well is started with a hole, ranging in size from 20 inches down to 13 inches depending largely upon the ideas and experiences of the organizations interested. The Peoples Natural Gas Co.'s No. 1,842 was started with a 16-inch hole and was drilled to a depth of 60 feet, in which was run 60 feet of 13-inch screw pipe. The following strings of casing were used in this well, 1,112 feet of 10-inch, 3,857 feet of 28-pound screw pipe, 6,289 feet of 30-pound 6¼-inch special internal upset screw pipe, 6,794 feet of 23-pound 4-inch welded pipe. The well was drilled to

The sand line is a five-eighths-inch wire cable throughout the drilling operation.

Many Bad Cavings

Many bad cavings are encountered in drilling deep holes, especially in those which reach a depth nearing the corniferous lime horizon. Just above the corniferous lime is a black, soft, running material, which the geologists tell us is the Marcellus black shale. Bailing of this material from the hole has been done for a month at a time. This material becomes exceptionally soft and annoying when water is allowed to gather on it; therefore, in order to keep the water from the walls of the well, it is necessary to lower the water in the hole by means of a bailer. Sometimes it is necessary to fill many of these large cave holes with cement in order to shut off the soft material from running into the hole. This cement is lowered into the hole by means of the dump bailer.

It is a very important part of deep drilling to place a long and heavy string of casing properly in the hole. These long strings of pipe, when connected together, will stand much more tension than they will compression; therefore, if they are allowed to stand on end, when the weight is too great, they will buckle and plug the hole. It can, therefore, be seen that it is necessary to carry part of the weight of the casing by being suspended from the surface. Referring to the Peoples Natural Gas Co.'s No. 1,842, the string of 4-inch welded pipe was lowered to the bottom of the hole, and an additional 10 inches was allowed at the top of the hole, so as to distribute the weight between tension and compression.

Increased Temperature

Due to the increased temperature as greater depth was reached, it was rather difficult to calculate the amount of stretch in a long and heavy string of pipe. The exact bottom of the casing was known at all times by the use of an implement designed by the writers and is illustrated in Figure No. 1. This implement is attached to the bottom of the bailer and lowered into the hole. The bottom of the hole being determined, the implement is raised until the side lugs catch on the bottom of the casing, which gives the distance from the bottom of the casing to the bottom of the hole.

Figure No. 2 illustrates the manner of casing the deepest cable tool well in the world. The sands encountered in this well are observed on the right-margin. It possibly would be of interest to note that this well started below the big lime horizon, which is being quarried on the mountain just above the well, and about the middle of the Big Injun sand.

In order to handle efficiently, the long and heavy strings of pipe that are necessary to run in the deep wells in the Appalachian Field, a five-sheave, 60-inch casing block, together with the five pulleys placed on the top of the derrick, referred to previously, are used to complete a set of blocks. A 1¼-inch casing line, a single link elevator and ring and slips complete the casing outfit. The above outfit was used in running 6,289 feet of 30-pound casing in the Peoples Natural Gas Co.'s No. 1,842 with an approximate weight of 188,670 pounds.

The Slanting Hole

Another difficulty encountered in deep drilling in the Appalachian Field is that of a sloped or slanting hole. The geologists tell us that due to the steep slopes of the anticlines and their narrow apexes, that the drill gets started off a vertical course, and is very easily led in that direction, due to the slopes of the horizons drilled through. This has been experienced in many of the deep wells in the Appalachian Field, and has been overcome by filling the hole with cement to a point where the hole began going crooked and commencing to drill at this point again. The slope of the hole was determined by the use of a container. (See Figure No. 3.) This container was made of copper and was of such a size as to fit snugly within the

bottom of the bailer, the dart having been cut off. Within this container was placed a bottle of known internal diameter. Within the bottle, hydrofluoric acid of a certain consistency was placed and the contents lowered into the hole. The hydrofluoric acid was of such a strength that it would etch the glass after standing about 15 minutes—the bailer then being drawn to the surface, the bottle removed and the slope measured. By simple trigonometry, the slope of the hole at the point at which the bottle was run, was then calculated. In this manner a complete survey of the hole was made, or at least that part of it that was deemed advisable.

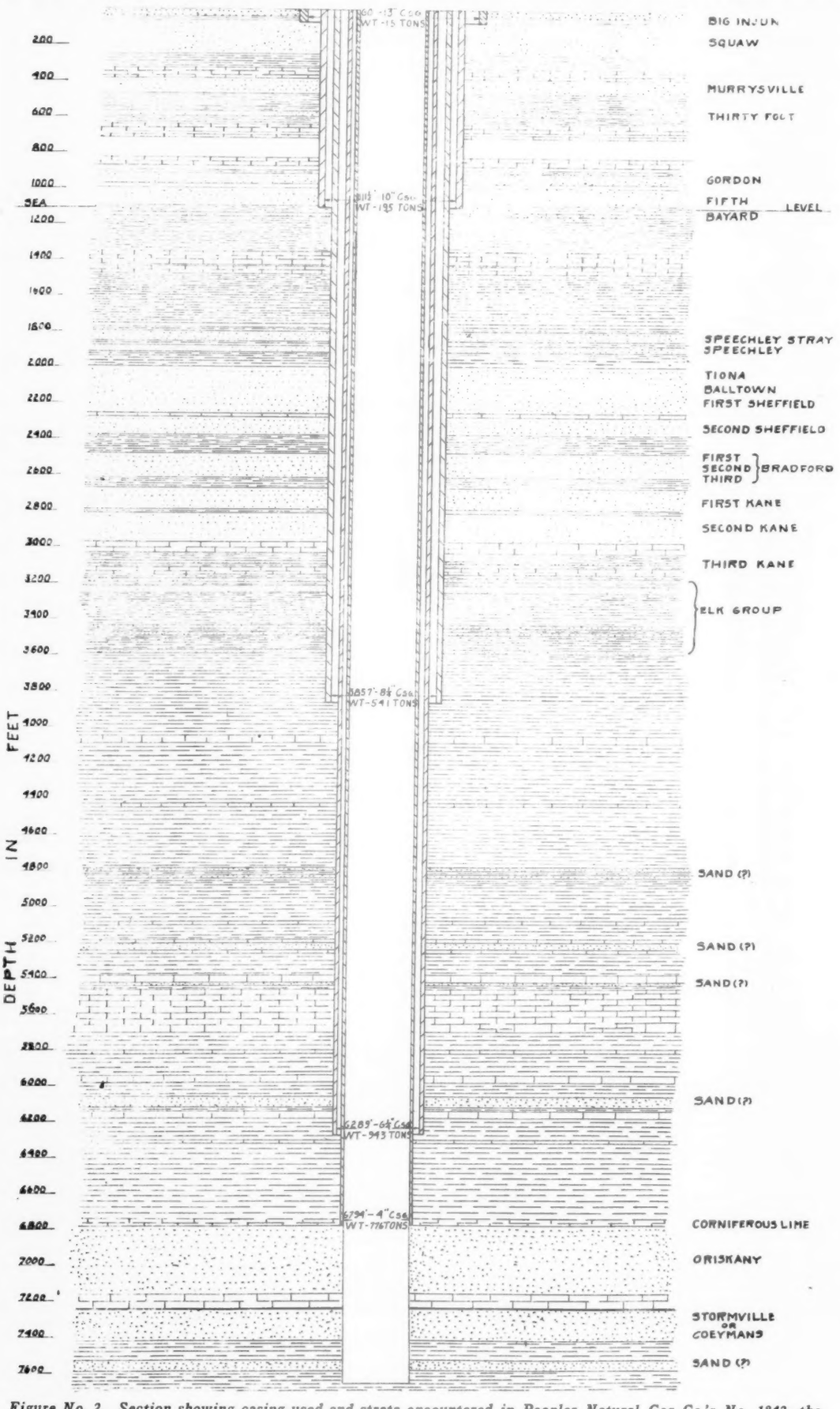


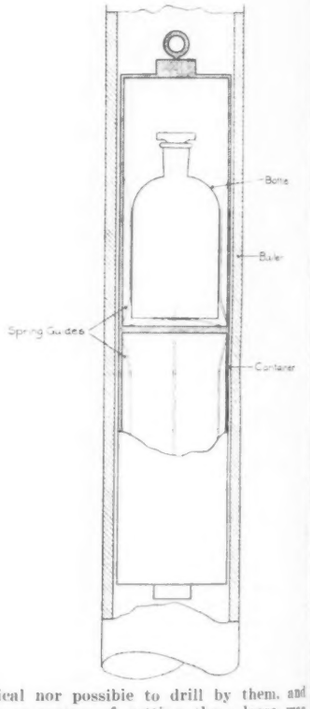
Figure No. 2. Section showing casing used and strata encountered in Peoples Natural Gas Co.'s No. 1842, the world's deepest well drilled for gas.

Fishing Jobs

One of the many fishing jobs encountered in deep drilling is explained as follows: After setting a string of 30-pound, 6-inch casing in the Peoples Natural Gas Co.'s No. 1,842, at a depth of 6,289 feet, a caving formation was encountered only a few feet below the bottom of the casing.

This cave was fought for many months without success and it became necessary to place tons and tons of cement in this hole to shut off the cave. The cement was lowered with the dump bailer and allowed to set from 10 days to two weeks. In the course of drilling through the cement, the tools were lost in the hole. We were successful in getting hold of them, but could not jar them loose, evidently the cement having settled around them; the upper part of the tools were still in the casing. After many attempts to jar them loose had failed, a long spear or spud was run down along one side the full length of the drilling tools, and again the tools refused to be moved. Since the tools extended up into the lower part of the casing, it was not practical nor possible to drill by them, and some means of getting them loose was necessary. It was decided to make a hollow drill-mill, 62 feet long, which was made and the tools telescoped completely. This drill-mill was made from seamless pipe, with a steel drill-mill on the bottom end, and with a tool joint on the top end. This implement proved very valuable, and after running it the length of the tools they were extracted from the hole and drilling continued. Many other disastrous fishing jobs are of record. We have knowledge of several bits, bailer, strings of tools, etc., that have been cemented in the walls and the hole completed with this equipment left therein.

ANGLE TESTING APPARATUS
USED IN DETERMING SLOPE OF HOLE
FIGURE 3



Another unusual handicap occurred in drilling this well. A gas was found which was very highly impregnated with sulphur and other impurities. When this gas came to the surface, and was exposed to the air, it had a very piercing effect upon the eyes and throats of the men who came in contact with it; in fact, it was so serious that several of the men working on this particular well had to go to the hospital for treatment. This difficulty was overcome by the use of gas masks.

An Alliance for Service

OIL WELL SUPPLY CO.
AND THE
R. D. NUTTALL CO.

"OILWELL" ESTD. 1862. TRADE MARK. (REGISTERED)

THE Oil Well Supply Co. are distributors for all Nuttall, single and double reduction, oil well, pump gear units. The Oil Well Supply Co., with over one hundred branches, covers every oil field, and thus Nuttall pumping units are universally available. At their warehouses, the Oil Well Supply carries stocks of Nuttall units from which they can make deliveries on very short notice. This distribution service, backed by the manufacturing facilities of the Nuttall Company (the largest manufacturer of diversified industrial gears in the world), assures oil men everywhere of Nuttall units when they are needed.

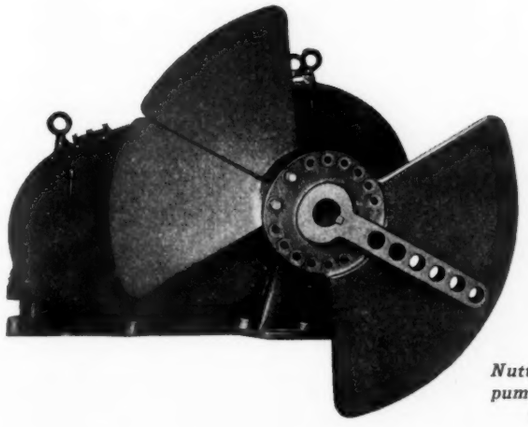
Nuttall

R. D. NUTTALL CO., Pittsburgh, Pa.

Houston
Union Nat'l Bank Bldg.

Los Angeles
420 S. San Pedro St.

Oil Well Supply Co., Authorized Distributor

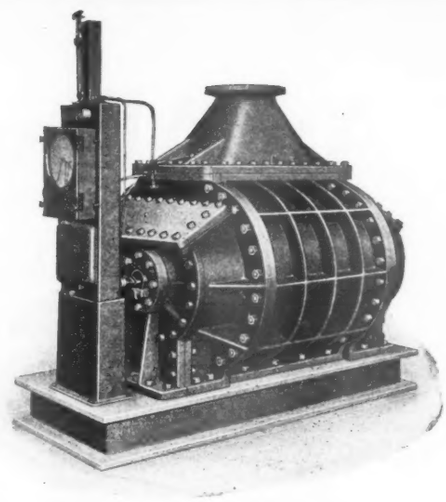


Nuttall, double reduction pumping unit, with counterbalanced crank.

We specialize in Natural Gas Financing and Invite Inquiries

A. M. LAMPORT AND COMPANY, INC.

44 PINE STREET NEW YORK



Dependable Accuracy in Gas Measurement

When the Rotary Displacement Meter was designed and offered to the gas industry by the Connersville Blower Company it set up a new standard for consistently recording gas flow.

The displacement per revolution of the meter is a fixed volume, mathematically calculated and easily proved.

The meter contains no parts requiring delicate adjustment to maintain accuracy, but is simply yet sturdily built, reducing maintenance costs.

The commercial accuracy is maintained throughout a range of 10% to 200% of normal rating and in a special type this accuracy of measurement is possible from 0 to peaks of 200% of normal.

Pressure loss across the meter is less than 1 inch water column.

Normal hourly volumes of 3000 to 700,000 can be handled by single meters from the standard line.

Connersville Rotary Displacement Meters are constructed to meet several pressure loads, each designed for its particular duty, with careful proportioning of parts. Consequently, they may be obtained for low pressure service to industrial consumers, for the 10 or 15 lb. city distribution system, or for the moderate pressures up to 50 lbs.

May we send you Bulletin 4C which illustrates the design and operation of these Connersville Meters? A postcard request is all that is necessary.

THE CONNERSVILLE BLOWER COMPANY
16th St. & Michigan Ave.
CONNERSVILLE, IND.

SALES OFFICES

623 Monadnock Block, Chicago
114 Liberty St., New York
604 Chamber of Commerce, Pittsburgh

CONNERSVILLE
Blowers · Gas Pumps · Meters · Cycloidal Pumps

Soil Corrosion Investigation Results

Rapid Corrosion of Iron and Steel Observed in a Few Soils Where There Were No Stray Electric Currents

By K. H. Logan*
In Charge of Bureau of Standards' Soil Corrosion Work

General Conclusions

While the investigation of the Bureau of Standards on soil corrosion has not progressed far enough to warrant definite statements, it appears that thin coatings applied as dips to pipe buried in soils proved unsatisfactory in a number of soils. The thicker coatings appeared better.

An important result of the test of bituminous coatings is to show that a coating which stands up well under some soil conditions may fail in other soils.

It seems that protective coatings, like pipes, should be selected with reference to the location in which they are to be used.

A number of societies and public utilities are undertaking corrosion studies. One thing greatly needed is a co-ordination of their work to avoid needless duplication of effort.

The origin, purpose and scope of the Bureau of Standard's Soil Corrosion Investigation have been stated too often to require repetition. The following summary of the results of the work as indicated by the specimens removed in 1926 must be considered as a progress report, since less than a third of the total number of specimens which were buried have been examined and because it is probable that as the work continues new factors affecting the corrosion of the specimens will appear. Conclusions at this time must, therefore, be tentative and subject to revision in the light of data to be secured later.

The scope of the work has become so broad that it seems advisable to report on it as five projects, although little can be said concerning any of them.

The specimens which have been in the ground longest are those representing commercial pipe materials. A report on these specimens was made two years ago, after they had been buried from one to two years. Another lot of these materials was removed in 1926 and a report on their condition will be presented at the annual meeting of the American Foundrymen's Association in June. Specimens of other materials also were removed in 1926 and reports on them will be published by the Bureau of Standards the latter part of this year.

Earlier Conclusions Confirmed

In a general way the results of the last examination of specimens of unprotected iron and steel pipe confirm the conclusions† drawn from the examination of the specimens removed two years earlier. Rapid corrosion of iron and steel has been observed in a few soils where there were no stray electric currents. With the exception of high-silicon cast iron, the mechanical properties of which limit its use, no one ferrous material under test has so far appeared superior under all soil conditions. There is a wide variation in the appearance of the specimens from different soils, but usually the corrosion patterns on all of the welded materials from the same soil are quite similar and the differences either in rates of corrosion or rates of pitting are usually small. This leads us to believe that there is an important relation between corrosion and some characteristics of the locality in which it occurs. What this relation is has not been determined but it seems probable that some physical or chemical property of the soil controls the rate of corrosion.

Another result of the investigation is the accumulation of additional evidence that the so-called graphitic corrosion which is frequently associated with stray current electrolysis may occur in the absence of stray currents. Graphitic corrosion products, which are really mostly hydrated ferrous oxide with which is mixed a few per cent of graphite and other impurities occurring in cast iron, are usually formed when corrosion occurs too rapidly for the complete oxidation of the corrosion products, and were found on all the cast specimens which suffered serious corrosion. It can now be definitely stated that graphitic corrosion does not necessarily indicate stray current electrolysis. The distribution of pits over the surface of the specimens varied from one or two per square foot to almost uniform corrosion. From this we may conclude that the form and distribution of the corrosion on a pipe does not indicate whether the soil or stray current is responsible.

Corrode Without Currents

The results of the soil corrosion investigation do not, at present, justify any conclusions as to the ultimate usefulness of any of the materials under test in any of the soils, the relative merits of these materials or the prevalence of corrosive soils. The test has, however, already shown definitely that rapid corrosion may occur without the presence of stray currents and that electrolytic corrosion cannot be distinguished from soil action by the form, character, or distribution of the corroded areas. Additional study of soil corrosion problems should show the extent of the known corrosive soils, produce methods for quickly telling whether a soil is corrosive, and suggest measures for preventing corrosion.

In recent years there have been offered a number of metals and alloys said to be more resistant than steel to corrosion. Samples of two kinds of lead and a number of brasses were removed in 1926.

Lead corroded in fewer of the soils under test than did steel and the depth of the pitting was less in almost all cases. Nevertheless, lead was found to corrode rather badly in a few soils.

At the end of two years little corrosion and almost no pitting have been found on any of the brass specimens although some of the yellow brass specimens have turned red indicating a selective corrosion of the zinc. No tests have been made to determine whether the strength of the alloy has been decreased. Little evidence of galvanic action between brass and lead or brass and galvanized iron screwed together has been observed, and the specimens of bronze welded joints in cast iron show little galvanic action although when the two surfaces are clean there is a considerable difference of potential between them.

Galvanic Action

It appears that the character of the corrosion product determines whether a galvanic potential will result in continued corrosion. This is an important result of the soil corrosion investigation, for a great deal has been written concerning corrosion due to dissimilar metals being placed in contact with each other in the earth. Such contact of metals at slightly different potentials is almost unavoidable, not only because the proper construction of underground lines requires the use of more than one material, but also because such potentials are often the result of impurities, strains, mill scale and differences in oxidation or other surface conditions when the metal used is nominally of one kind throughout. While undoubtedly corrosion may arise from these galvanic potentials, there is a fair chance that it may not continue because of the formation of protective films, polarization or some other change in conditions after the pipe is buried.

Specimens of zinc and also of duralumin showed serious corrosion in two out of five soils in which they were buried. The corrosion of the zinc is of interest in connection with the data recently obtained on metallic protective coatings, four of which are under test.

Specimens 6 inches by 12 inches of 16-gauge sheet with approximately 2-ounce coatings of zinc on three base metals and two kinds of galvanized pipe have been buried in most of the 47 test soils. Those removed after two years show various stages of deterioration, but as yet the effect of the character of the base metal is not apparent. As is the case with the bare pipe, the galvanized specimens indicate that the rate of corrosion depends largely on soil conditions. In most of the test locations the corrosion of the galvanizing was slight. In a few soils practically all the galvanizing has disappeared and the sheets are rusted or pitted.

In some soils where iron corroded rapidly the galvanized material shows little loss, and in a few locations there has formed on the surface of the galvanized pipe a corrosion product which has much the appearance of varnish. Whether this corrosion product is so continuous as to completely protect the pipe cannot be determined at present. A study of this corrosion product and the conditions under which it forms might lead to the development of a protective coating suitable at least for some soil conditions.

Lead and Lead Coatings

While the specimens of sheet lead showed little corrosion in all but a few locations, so much cannot be said for the specimens of lead-coated pipe. Fifty-six out of 87 specimens removed showed pits 0.02 inch deep or deeper and in a number of soils the pits were deeper than on the corresponding specimens of unprotected steel pipe. This accelerated corrosion is attributed to galvanic action at points where the lead coating was imperfect. The loss of metal from the lead coated specimens is usually quite small, but the pits are frequently deep and in a few cases there is a hole through the pipe wall. The particular type of lead coating under test, therefore, appears unsatisfactory for pipes which should be leak proof, although it might be suitable for the protection of structures where the maintenance of mechanical strength only is essential.

The Bureau of Standards' tests of bituminous protective coating materials cover only types of coatings applied at the pipe mill or in a pipe yard and do not include certain other materials which may be so applied. While the tests are inadequate on this account the results are interesting and suggestive.

Thin Coatings Unsatisfactory

In general, it may be said that all of the thin coatings applied as dips proved unsatisfactory in a number of soils. They became brittle and rust formed beneath them. The thicker coatings obtained by the use of fabric impregnated with asphalt or coal tar pitch appeared better, but in several instances there was evidence of deterioration of the asphalts. All of the asphalts tested are of the air-blown variety. Whether a natural asphalt would give different results is not shown by the tests.

An important result of the test of bituminous coatings is to show that a coating which stands up well under some soil conditions may fail in other soils.

It appears that protective coatings, like pipes, should be selected with reference to location in which they are to be used. So much has been said recently concerning certain proprietary materials and processes for protecting pipes and so many cases of long life of pipe protected by these materials have been cited that a comparative test of these and several other protective coatings under a variety of soil conditions seems desirable. Such a series of tests would doubtless lead to

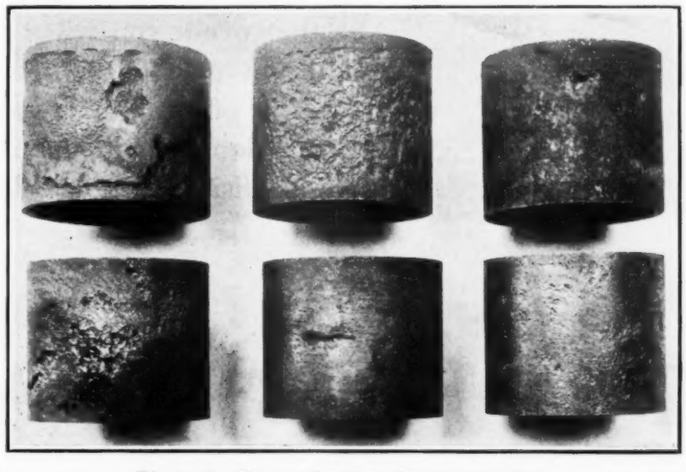


Figure 1. Types of soil action on cast iron.

*Published by permission of the Director of the National Bureau of Standards of the United States Department of Commerce.

†Trans. American Foundrymen's Assoc., Vol. XXXII, page 144.

QUALITY — QUANT

Special Attention T

To *Construction Engineers*

of Gasoline Plants and Gas Lines ....

WHEN you specify your requirements for Gasoline Plants and Compressor Stations, you endeavor to secure the best engines and other machinery that Mechanical Science has perfected. Therefore, be sure to specify Number One New or Dependable Used Pipe FOR YOUR LINES to harmonize with the quality of your other equipment.

MILL SECONDS and inferior grades of used pipe are bound to cause loss of gas on a compressor plant, or overloading your machinery with air on a vacuum plant. In either event you will be money ahead using first class pipe at a slightly higher initial cost, which difference will be offset in maintenance as long as your plant is in operation and will mean One Hundred Per Cent salvage if you dismantle your Plant or Lines.

TAUBMAN SUPPL

NTITY — SERVICE

To *The* Mid-Continent *Purchasing* Agents

WE are pleased to announce the opening of our Seminole Plant (adjacent to the Carter Warehouse) equipped with the latest type machinery for cutting and threading pipe from one inch to twelve and one-half inclusive. With a complete stock of Central Tubular Products and Smith-steel Couplings. In addition to our new tubular products we are carrying a large stock of dependable used pipe in all sizes.

Seven years ago the Taubman Supply Corporation was established upon the firm foundation of a SQUARE DEAL TO ALL. Today we rank as one of the largest and most reliable Organizations in the pipe business, both morally and financially.

With hundreds of thousands of dollars invested in the most modern Pipe Yards and Plants located at Tulsa and Seminole, Oklahoma, Phillips in the Texas Panhandle and Eldorado, Kansas, we have every facility for handling pipe from a carload to a trainload.

As a Taubman customer, Taubman QUALITY, QUANTITY and SERVICE protects you against MILL SECONDS or doped used pipe. Explanation of which you will find details on our pages 78 and 79 of the May 26th issue of The Oil and Gas Journal.

You can depend upon our service for immediate shipment from our enormous stocks of new and dependable used pipe out of our nearest Branch.

TAUBMAN SUPPLY CORPORATION

General Offices: Midco Building
TULSA, OKLAHOMA

District Sales Offices: 1424 Niels Esperson Bldg., Houston 403 Magnolia Bldg., Dallas, Texas

Branches

EL DORADO, KANSAS SEMINOLE, OKLAHOMA, PHILLIPS, PANHANDLE, TEXAS

PLY CORPORATION

the improvement of some of the proposed coatings and be of great value to the pipe user who desires to secure a coating adapted to his soil conditions. Probably there is no one best coating, but there may be several which under certain conditions are entirely satisfactory. The problem is to discover where to use and where not to use these coatings.

Laboratory Tests

While waiting for corrosion to develop on the buried specimens, the Bureau has made a number of laboratory tests which deal with corrosion phenomena. The results of most of these tests have been negative. Nevertheless some are of value. We have not been able to associate, chemical analyses of soils with their corrosiveness except under a few conditions. The accelerated corrosion tests which we have tried usually do not check with field results. If we know what type of corrosion is obtained, we can often find a theory to explain it, but usually it is impossible to predict the corrosion from the theories which seem applicable. This is not intended as a criticism of the theory of corrosion or of laboratory corrosion work but to indicate that much more must be done before theory and laboratory tests will solve specific corrosion problems.

There has recently been a large increase of interest in soil corrosion and a number of societies and public utility companies are undertaking corrosion studies. One of the things greatly needed is a co-ordination of their work so that needless duplication of effort may be avoided and so that the beginner may avoid the mistakes of those who have had experience. An organization representing the societies and other bodies actively interested in corrosion might be very helpful in advancing the study of corrosion.

ELECTROLYSIS AND ITS PLACE IN CONSIDERING SOIL CORROSION

By K. H. Logan*
In Charge of the Bureau of Standards' Soil Corrosion Investigation

The mitigation of a continuing or recurring trouble is frequently best accomplished through the removal or at least an understanding of its cause. This is particularly true with respect to corrosion, for many of the remedies which are effective against electrolysis do not prevent soil corrosion, while most measures which will protect pipes against soil corrosion are ineffective against electrolysis.

Not many years ago electrolysis conditions were worse than at present and there were grounds for assigning corrosion not easily accounted for otherwise to the action of stray electric currents. Recently there have been brought to the attention of the public a very considerable number of cases of rapid corrosion of pipe which could not be attributed to this cause. This experience of operators of pipe lines has been confirmed by the results of the soil corrosion work of the Bureau of Standards which also show that rapid corrosion of buried pipes may, under some conditions, occur in the absence of stray currents.

As a result of these developments, a considerable interest has been manifested in what, for lack of a better term, is frequently called soil corrosion, and in some sections there is a tendency to overestimate the amount of corrosion due to this cause, just as at an earlier date the importance of electrolysis was overestimated. The purpose of this paper is to discuss briefly corrosion due to stray electric currents and to soil action, to describe means of determining whether corrosion is due to electrolysis and to mention some methods of preventing corrosion due to the two causes.

An Electrolytic Phenomenon

Much has been written concerning the theory of corrosion. It is sufficient for the purposes of this paper to call attention to the fact that there is now a rather general agreement that all corrosion is an electrolytic phenomenon, although it must be added that this has come about through so wide an extension of the electrolytic theory of corrosion that it is doubtful whether its originator would recognize his product.

If the electrolytic theory is correct, the fundamentals of corrosive action are the same for both stray current electrolysis and soil corrosion, although the origin of the currents are quite different. The action being fundamentally the same in all cases, we can hope to distinguish the causes of corrosion only through secondary reactions, if at all.

For practical purposes we may define electrolytic corrosion as that due to currents originating in electrical machinery and soil corrosion as that which is independent of such electric currents, although it may be due to or at least involve electrolytic action by currents confined to a limited area adjacent to the seat of corrosion. It should be made clear that the term "soil corrosion" as here used includes all corrosion occurring at the junction of metal with soil not due to stray electric currents and that the real cause may be nonhomogeneity or other characteristic of the metal, or some other local condition for which the soil is really not responsible. That is, we will call it soil corrosion, although in fact the soil may be, as it were, a bystander implicated by circumstantial evidence only. So far at least as the Bureau of Standards' soil corrosion investigation is concerned, while the data show that corrosion can occur in the absence of stray electric currents there are no data directly indicating that corrosion found in a given type of soil is to be expected wherever that type of soil occurs, nor are there data showing what soil property is responsible for corrosion. Indeed, the data so far examined indicate that the observed corrosion cannot be closely associated with any one soil characteristic. At present the Bureau of Standards' tests do not indicate the life of the pipes under test in any of the soils nor the extent of the soils in which serious corrosion has been observed. Until data on these subjects are secured the importance of soil corrosion will remain in doubt.

Evidence of Electrolysis

The relation of soils to corrosion is an almost unexplored field in which much profitable work could be done.

Whether the electric current always associated with corrosion originates in an electric machine is due to small galvanic cells, by which, according to the electrolytic theory, all corrosion originates, it remains true that there is usually a close relation between the quantity of electricity transferred from the corroding metal and the amount of corrosion. In this lies a partial justification for the assumption that rapid or extensive corrosion is due to electrolysis since we know that the use of electric machines is one of the easiest ways for generating electricity in quantity. It is now known that while stray currents can cause rapid corrosion similar results can be produced otherwise. Rapid corrosion, then, may suggest but not be proof of electrolysis.

Another evidence of electroylsis is the distribution of the corroded areas. Since the distribution of currents among several available paths is such that the circuits of the total current will be completed with the minimum expenditure of energy, current usually leaves a buried conductor for the earth at such points as enable it to reach other buried conductors easily, i.e., at intersections or points of near approach of these conductors. The discharge of current from a pipe to the earth is therefore usually very nonuniform in its distribution along the surface of the pipe, and this nonuniformity is accentuated by the nonuniformity of the protective coating, mill scale or corrosion products on the pipe surface. Figure 1 shows six specimens of cast iron pipe from the Bureau of Standards' soil corrosion investigation. The pipes in the upper row are sand cast and show co
rosion of three types; patches, near
uniform corrosion and occasional pi
The lower row are centrifugally co
specimens showing similar types of co
rosion; that of the middle specimen bei
due to a casting flaw.

Figure 2 shows eight types or degre
of corrosion of steel pipe. There is n
probability that any of these specimen
were subject to stray electric current
We must conclude, therefore, that a
most any type of corrosion can occu
without electrolysis and that the appea
ance of the pipe is not in itself sufficie
to determine the cause of the corrosio
If, however, the corrosion can be ass
ciated with corrosive materials such a
cinders or furnace slag, or if the pos
tion of the corrosion can be associate
with the approach of the pipe to a stree
car track or another buried structur
with respect to which the corroded pip
is anodic, the case is quite different.

Graphitic Corrosion

It is quite common to assume that the presence of so-called graphitic corrosion on a cast iron pipe is evidence of electrolysis. Now gray cast iron, from which pipes are made, contains from 2 to 3 per cent of free carbon in the form of small graphite flakes. When corrosion occurs part of the pure iron, ferrite, goes into solution and often is carried away from the pipe, while another part takes on moisture and oxygen to form hydrated ferrous oxide, a soft dark colored substance. The color and softness of the corrosion product has led many to think that it is graphite and it is usually called "graphitic corrosion," although a test with a magnet will show that it is magnetic, a property not possessed by graphite. While analyses of the product show it to be higher in carbon than was the original pipe material, this is due to the removal of part of the iron and not by the accumulation of carbon. If the corrosion product is exposed to the air it will gradually turn red and approach the appearance of ordinary rust. A number of cases of the formation of the so-called graphitic corrosion in the absence of stray electric currents have come to the notice of the public and it has been shown recently by the Bureau of Standards' soil corrosion tests that the graphitic form of corrosion of cast iron is merely due to incomplete oxidation of the iron, i.e., to corrosion so rapid that oxygen could not reach the corroding iron rapidly enough to form at once the ferric oxide. Graphitic corrosion is, then, merely an evidence of corrosion in a limited supply of oxygen, but on finding it we may infer rapid corrosion, and since electrolysis is often responsible for rapid corrosion we frequently reach the unwarranted conclusion that graphitic corrosion indicates electrolysis.

Rate of Current Discharge

There is, then, no characteristic difference either in form or composition whereby we can tell from the corrosion alone whether it is due to electrolysis or soil action. To be assured of electrolysis we must find the stray current. Fortunately, the character and habits of this enemy are now so well known and means of its identification so developed that in the great majority of cases it is possible to determine with considerable certainty whether the corrosion is electrolytic. Since the rate of corrosion is roughly proportional to the rate of discharge of current, the logical procedure is to determine the rate at which current is being discharged from the corroded area. This can be done and should be done before the removal of the corroded pipe in all cases where electrolysis is suspected and circumstances permit.

When the renewal of the pipe cannot await the test, conditions should be restored as nearly as possible and the test then made. There are a number of ways of testing for and of measuring the discharge of electricity, but most accurate is probably by the use of the earth current meter developed by the Bureau of Standards. This instrument indicates the magnitude and direction of the current in the earth at the point tested and from these data the rate of cor-

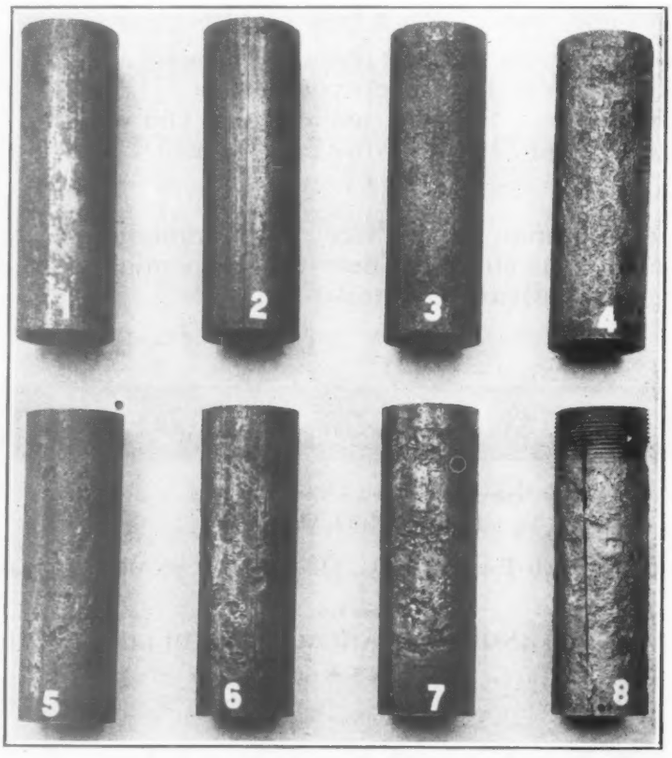
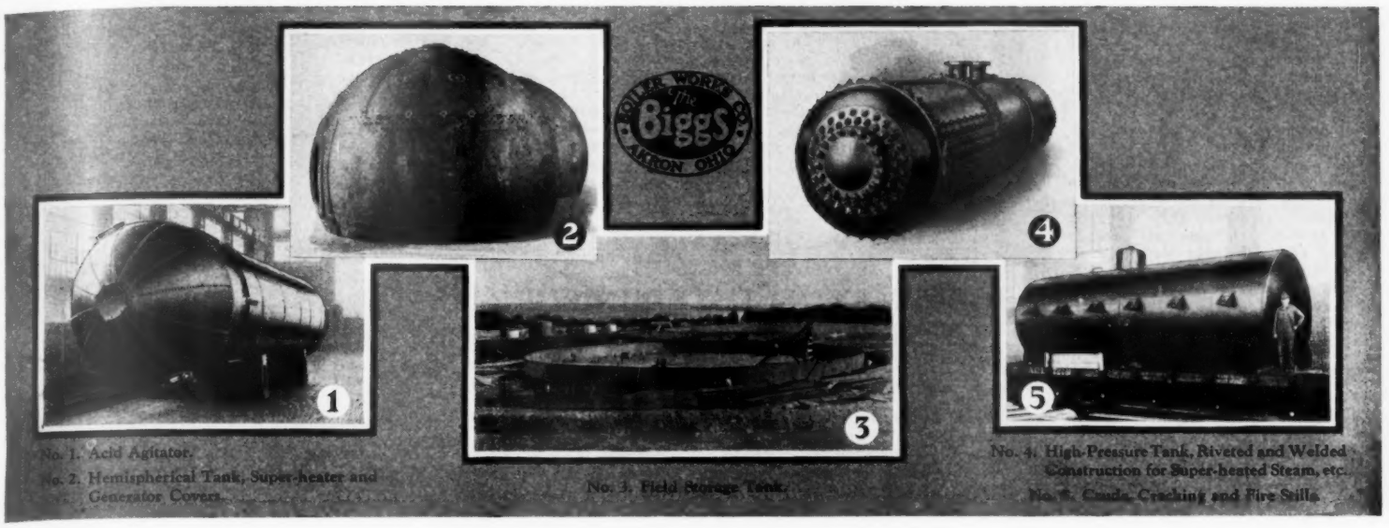


Figure 2. Types of Corrosion.
1. Unaffected, in Everett gravelly sandy loam. 2. Etched, in silt loam. 3. Roughened, in Keyport loam. 4. Blotched, in Memphis silt loam. 5. Few pits, in Hagerstown sandy loam. 6. Deep pits, in Marshall silt loam. 7. Wormeaten, in sandy loam. 8. Corroded areas, hole in wall, corrosion at weld, in white alkali.

*Published by permission of the director of the Bureau of Standards, Department of Commerce.



No. 1. Acid Agitator.
No. 2. Hemispherical Tank, Super-heater and Generator Covers.
No. 3. Field Storage Tank.
No. 4. High-Pressure Tank, Riveted and Welded Construction for Super-heated Steam, etc.
No. 5. Cracking and Fire Stills.

Look at the Pictures!

They Are Typical of Other Heavy Steel Plate Work Biggs Fabricates for the Gas and Petroleum Industries

BIGGS specializes in just such heavy duty, high pressure equipment, and offers you *complete* facilities for fabricating and erecting steel plate work of every sort up to 1½" thickness. (We use the word "complete" advisedly.)

Most important of all, the name of Biggs stands for accuracy—for sheer, conscientious, unswerving precision. For more than 40 years, that ideal has given a positive, sure meaning to Biggs construction. To be "Built by Biggs" means to be "Made Right—Always Tight."

What are your needs? High pressure equipment? Some of the other items listed to the right? In any case, why not train Biggs' 40 years' experience upon your present problems and requirements?

Manufacturers of

Separator Shells
Casing Head Storage
High Pressure and Accumulator Tanks
Settling Tanks
Gas Holders
Scrubbers
Wash Boxes
Generator Shells
Waste Heat Boilers
Smokestacks and Breechings
Storage Tanks to 80,000 Barrels
Riveted and Carbon Arc Welded Steel Pipe
Fuller's Earth Dryers
Special Refinery Equipment
Agitators, Stills, Hemispherical Tanks
and a Complete Line of Refinery Equipment.

THE BIGGS BOILER WORKS COMPANY
General Offices and Works: Akron 35, Ohio
Eastern Sales Office: 300 Madison Ave., New York City
Chicago Office: 35 South Dearborn St.

PLEASE ATTACH TO YOUR LETTERHEAD.

The Biggs Boiler Works Company,
Akron 35, Ohio.

Send "What Biggs Does and How" to

Name .....

We are particularly interested in .....

.....

Name .....

Address .....

The Biggs BOILER WORKS CO. AKRON OHIO EST. 1887
TRADE MARK REGISTERED

TANKS AND GENERAL
STEEL PLATE WORK
for the Oil Industry

rosion of a pipe at that point can be calculated, and the seriousness of the rate of corrosion due to this current estimated with a fair degree of accuracy.

The earth current meter does not distinguish directly between street railway current and that due to galvanic action and indeed the instrument is not infrequently affected by galvanic currents. Fortunately, however, it is usually possible to distinguish between the two. In the first place, the amount of galvanic current picked up by the earth current meter is almost always too small to indicate rapid corrosion. This is partly because galvanic currents are usually small and partly because the construction of the earth current meter contactors is such that they pick up but a small portion of any galvanic current that exists. The circuit of a galvanic current is between two adjacent particles of different material and the space occupied by the greater part of the lines of current flow is too limited to be occupied by the terminals of the contactor. Moreover, galvanic currents are usually steady or change gradually, while street railway currents at a given point in the earth fluctuate rapidly and widely with changes in the positions of the street cars and the amounts of currents they consume.

Sources of Current

Whether the current found is due to street railways can usually be determined then, by its steadiness, but in cases of doubt the street railway system may be momentarily shut down or the test may be repeated at night when the street railway load is off or at least greatly reduced.

Cases occur, of course, in which the corrosion may be due to electrical conditions not prevailing at the time of test. This can usually be determined by a study of the electrical history of the neighborhood involved. Changes in the location of the powerhouse, in the system of electrolysis mitigation or in the underground pipe networks must be considered, but the effects of such changes can often be estimated and in some cases former conditions can in part be temporarily restored.

Such are the ways in which electrolysis may be identified. At present there is no reliable and rapid test for determining the seriousness of other causes of corrosion. Soil analyses are rarely of value and at present laboratory tests cannot be depended upon to reproduce field conditions.

Where it is anticipated that questions as to the cause of corrosion may be raised it may be advisable to bury short lengths of pipe at intervals along the side of but not touching the pipe line involved. Any corrosion found on these pieces of pipe can under normal conditions be assigned to soil action.

Co-Operation of Utilities

The remedies for electrolysis depend largely on local conditions. Although the producer of the destructive current is primarily responsible for it, there is a limit to what he can be expected to do and the pipe owner also has a responsibility. For that reason, the Bureau of Standards has frequently recommended that electrolysis problems should be treated jointly by all the utility owners occupying an affected territory. The remedy should lie in the limiting, confining or directing of the stray currents. The means by which this can be done have often been discussed and are still subjects of controversy.

Remedies for soil corrosion are limited and not altogether satisfactory in character. In studying protection against soil corrosion it is well to remember that the term probably covers a wide variety of causes of corrosion, some due to the character of the pipe materials used, some to combinations of these materials, some to foreign material in the trench and some, perhaps, to soil characteristics. Soils, themselves, vary greatly in origin and character and it is not to be expected that a material or method suitable for preventing one kind of soil action will be just as effective against the action of a widely different soil.

The conclusions which can be drawn from the limited amount of data so far collected in the Bureau of Standards' soil corrosion investigation have been presented elsewhere† and are available for study. They may be summarized by saying that to date, the ferrous materials under test have corroded more or less similarly, though not at exactly the same rates. The materials appearing best in some soils are perhaps not so well adapted to other soil conditions, although the life of any material in any of the soils has not been determined. Galvanizing retards the action of some soils considerably but is of very temporary value in others. The thin bituminous coatings under test proved disappointing in several locations, but heavier coatings appeared to offer at least temporary protection and at present an effective bituminous coating appears to offer the best chance for immediate relief from soil corrosion. Whether such a coating satisfactory under all soil conditions has been developed has not been demonstrated. A further study of soil corrosion and its instigation is earnestly recommended.

†Trans. American Foundrymen's Association, Vol XXXII, page 144; Trans. American Institute of Mining & Met. Engineers, 1927.

PROBLEMS SUGGESTED IN BUREAU OF STANDARDS' SOIL INVESTIGATION

By K. H. Logan*

In Charge of the Bureau of Standards' Soil Corrosion Investigation

There is a rather general impression that the National Bureau of Standards is conducting a thorough investigation of the corrosive action of soils on materials suitable for underground use.

Since, in a few instances at least, other organizations have been influenced in their decisions regarding the study of soil corrosion by a desire not to duplicate work already undertaken, it may be well to state briefly the scope and limitations of the bureau's soil corrosion work.

The work was begun in 1922 primarily for the purpose of determining whether soils might be responsible for some of the corrosion of gas and water mains observed in the course of electrolysis investigation. While it was hoped that other information also would result, the primary purpose governed the method and scope of the tests originally planned and limited the later extension of the work.

The specimens now under test† include 20 varieties of bare iron and steel pipe material, 24 varieties of bare nonferrous metal, 17 kinds of bitumen coated pipe, galvanized material with 6 weights of coatings, some of which are applied to three varieties of iron or steel, and two each of lead and aluminum coated pipe.

Pipe Deteriorates Rapidly

The pipe specimens buried in 1922 were 6 inches long and from 1½ to 6 inches in diameter. The pipe coatings are applied to 1½ and 2-inch pipe from 17 inches to 24 inches long. The nonferrous materials include a variety of shapes and sizes. Most of the specimens were cleaned, numbered and weighed before burial. The total number of specimens in the test is approximately 14,000. They are buried at depths of from 2 to 5 feet. The method of conducting the investigation was determined largely by its purpose. The work was organized as a co-operative undertaking by manufacturers and users of pipes to secure corrosion data with respect to commercial pipe materials under ordinary working conditions. Sufficient kinds of materials and soils were selected to be representative. Enough of each kind of material was secured to permit periodical determinations of the progress of the corrosion without interfering with the specimens to be removed later. The investigation is, therefore, of a practical rather than a scientific nature, limited in scope and with a definite object in view.

After four years, part of the answer to the problem is at hand. We can say with considerable assurance that under a number of conditions pipes deteriorate rather rapidly even when unaffected by stray electric currents. Later results will show more definitely the rates of this deterioration, and whether some pipe materials are better able to resist corrosion than others. The primary purpose of the investigation will then be largely accomplished, but the relative importance of soil corrosion will not be fully shown because the extent and distribution of the corrosive soils are not being determined.

The study of the problem outlined above has raised other questions and called attention to the need for additional information concerning corrosion. Having realized that corrosion in the absence of stray electric currents does occur to a serious extent in certain localities, we wish to know how and why it occurs in order that we may prevent or at least reduce the losses due to it.

The data in hand and those which will be obtained later should form the basis for more detailed study of corrosion problems, and the organization already formed affords opportunities for further tests that may be carried on at much less expense than would be necessary if the additional tests were undertaken independently by other investigators.

It is desirable, therefore, to study the plans and scope of the present investigation for the purpose of seeing just what additional information can be obtained therefrom either directly or by supplementing it by other tests.

In order to make the results of the test directly applicable it was necessary to simulate as nearly as possible working conditions. This involved selecting materials and soils of which many of the characteristics are unknown. This introduction of an undetermined number of variables which could not be independently controlled prevents a detailed analysis of the results and a valuation of their several elements. The data are not such as will permit us to determine just why or how corrosion occurs in the soil. To answer these questions other tests are required.

Cause of Corrosion

We have frequently spoken of the corrosion observed as soil corrosion and have associated the rate and character of the corrosion with the name of the soil in which the corroded specimens were buried. Actually the determination of the justification for this assumption is one of the unattacked problems. We have found badly pitted pipes in Susquehanna clay. Is Susquehanna clay the cause of the corrosion and is the corrosion due to the texture or to the composition of the soil, i. e., should we expect corrosion in all clays, in all Susquehanna clays or is the observed corrosion due to something entirely independent of the properties of the soil in which these specimens happened to be buried such as the temperature, moisture, their location with respect to other things on or above the ground, etc.? One test will not answer the questions and it will not be answered by the tests under way although an answer could be obtained without much difficulty. Since all the rolled metals which were buried in this soil have corroded similarly, the burial of a few samples of one material in several Susquehanna clays, and others of the same material in Susquehanna soils of different textures would be expected to furnish the needed data.

Similar tests should, of course, be made in a few other soils. As a result of such tests we would expect to know whether the mechanical or the chemical properties of the soil determined its corrosive action and whether the system of classification of soils adopted by the Department of Agriculture is satisfactory as well for determining the location of corrosive soils and whether it can be used for determining the extent of corrosive soils.

Analyzing Soils

We have under observation 47 soils. There are in existence several thousand varieties. To get data directly on each of these is obviously impracticable. We need, therefore, some method of quickly determining whether a soil in which we are interested is corrosive. It is desirable, therefore, to analyze soil characteristics and to ascertain which of them affect corrosion. Numerous chemical analyses of soils have been made, but except in a comparatively few cases these analyses have offered no apparent clue to soil action and much study will be required before the analyses can be properly interpreted. The mechanical properties of the soil and its position with respect to drainage may be of greater importance than its chemical constituents and these should be carefully investigated.

A number of tests of a more or less empirical nature have been proposed for the rapid determination of soil corrosiveness. One of the difficulties with these has been that there was no way of closely checking their results with field experience. This check we now have, in a limited way at least, in the Bureau of Standards' corrosion data, and the more promising accelerated tests should therefore be tried on soils whose action we know. This will give the key to their dependability. The study of soil characteristics together with the development of proper quick or accelerated tests should enable the corrosion expert to make simple tests whereby he can tell whether a soil is responsible for observed corrosion and whether a soil would seriously affect a selected pipe material. The value of such information is evident.

For most people the reason for studying corrosion is the hope of reducing the losses due to its action. When we know more about corrosion we will better know what to do about it. There are, however, some mitigative measures which may be studied before our information regarding corrosive action is complete. These have for their object the keeping of the pipe away from the corrosive soil. How to do this economically and permanently is a subject of considerable controversy. Many methods of protecting pipe are under trial and new tests are frequently planned. The first great need in connection with studies of pipe protection is the collection and study of data on what has already been done. Information should be obtained as to what methods were tried, the conditions under which the work was carried out, the extent to which it was successful and the reasons for failures. With such data it would be possible to plan future work economically. Methods suitable for some conditions may be unsatisfactory for others.

Bituminous Coatings

The most common protective method is the application of a coating usually of a bituminous nature, but of a variety of materials applied in a number of ways. Having found by study of the results of past experiments several protective coatings which had been reported satisfactory under some conditions these should be tried out by applying them to short sections of working pipe lines passing through widely different soils. The advocates of the chosen materials should be made responsible for their proper application, and representatives of prospective users should observe and report on the success of the results. Within a few years the usefulness and limitations of a number of coating materials and methods of application would be known with the result that both materials and methods would be improved and much corrosion loss avoided. While the tests are under way, experiments should be carried on for the purpose of developing methods of quickly determining whether and under what conditions a new coating will prove satisfactory. In due time it might be possible to write a specification for a coating or for tests which a coating should pass.

*Published by permission of the Director of the Bureau of Standards, Department of Commerce.

†See Transactions, American Foundrymen's Association Vol. XXXII, page 144.

PIPE

RECONDITIONED

THREADED LINE PIPE

PLAIN-END ODEE
DOUBLE LENGTH PIPE

STANDARD RAIL & STEEL CO.
MADISON, ILLS.

30,000 ft. 2" LINE PIPE
10,000 ft. 3" LINE PIPE
35,000 ft. 4" LINE PIPE
10,000 ft. 6" LINE PIPE
3,000 ft. 8" LINE PIPE

100,000 ft. 4" OD PLAIN END WELDED DOUBLE LENGTHS
50,000 ft. 5⅜" OD PLAIN END WELDED DOUBLE LENGTHS
50,000 ft. 3½" OD PLAIN END WELDED DOUBLE LENGTHS
50,000 ft. 2¼" OD PLAIN END WELDED DOUBLE LENGTHS

WRITE FOR PRICES BEFORE PURCHASING ELSEWHERE

STANDARD OIL ISSUES

New
Statistical Circular
on
PIPE LINE COMPANIES

Copy upon request

CARL H. PFORZHEIMER & CO.
(Specialists in Standard Oil and Miscellaneous Oil Securities)
25 Broad Street New York, N. Y.

C. A. DALLY, JR.
Manager

T. J. HEARD
Sec'y-Treas.

Reserve Natural Gas Company
of Louisiana

·.NATURAL GAS·.
·.PIPE LINES.·

General Offices
Slattery Building Shreveport, La.

Tulsa Pipe and Supply Co., Inc.

Tulsa, Oklahoma

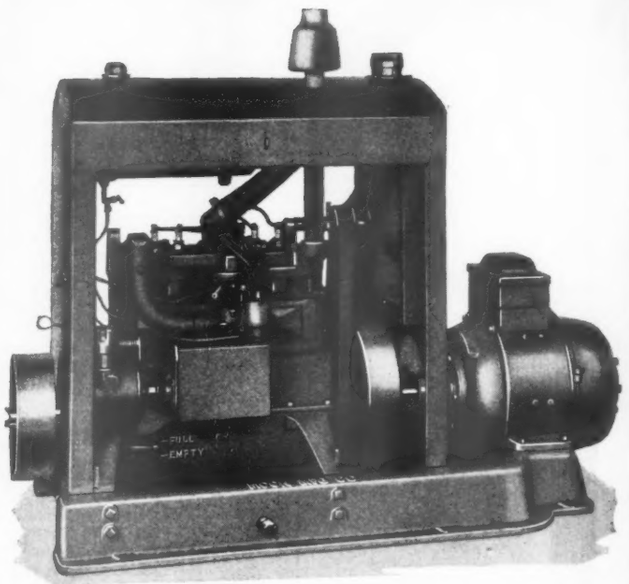
Announcing removal of our general offices to 306-307-308 Tulsa Trust building and warehouse and yards to Dawson Road and Sanders Street in East Tulsa Industrial District.

Line Pipe—Casing
Oil Well Supplies

We have the largest and best equipped machine shop in the heart of the Texas Panhandle, located at Borger, Texas. Mr. T. P. Looney is general manager in charge of Texas operations.

Tulsa Pipe and Supply Co. of Texas

Borger, Texas



Moon Gas-Electric Lighting Plant. Capacities—1½, 2¼, 3 and 4 KW.

MOON LIGHTING PLANTS
For All Requirements

No matter what kind of power you are using for drilling—whether steam or gas—there is a corresponding type MOON Lighting Plant to give you that reliable service which you require.

If your power is gas—there is the New MOON Gas-Electric Equipment, the "Wonder Lighting Plant of the Oil Fields." Designed specially for Oil Country service, it has many exceptional features which will appeal instantly to the progressive driller. The LeRoi Engine, well known for its ruggedness and ability to stand hard service, is used as a source of power in this unit. Ample engine capacity has been provided for operating auxiliary equipment such as blowers, pumps, etc., by belt from the pulley mounted on the engine end of the shaft. Another indication of the extreme flexibility of this outfit is the special clutch coupling, by means of which the dynamo can be disconnected and the entire capacity of the engine used for other purposes.

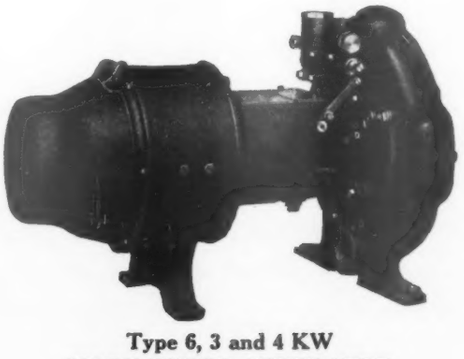
The dynamo is equipped throughout with oversize ball bearings which are lubricated by a constant spray of oil. Special winding and the use of interpoles eliminates all chance of sparking at the commutator, and also maintains a constant voltage at varying loads without the use of a rheostat. A rugged steel housing, fully enclosing the outfit, is furnished as standard equipment. MOON guaranteed in all respects.

If you use steam—there are MOON Turbo Generators in capacities from 1 to 4 KW for all sizes of jobs. Originally the pioneer electric light plant of the oil fields, they have been constantly improved and now include such features as automatic lubricating system, special steam nozzle arrangement, oversize sparkless commutator.

We will be glad to send you descriptive bulletins on either steam or gas-operated types.

MOON Lighting Plants and accessories are carried in stock by the leading Supply Stores in all fields.

THE MOON MANUFACTURING COMPANY
108-128 North Jefferson Street
CHICAGO



Type 6, 3 and 4 KW
MOON TURBO GENERATOR

Production of Helium Commercially

When We Entered War in 1917 This Gas Cost $1,500 a Cubic Foot. Now It Is Made at Cost of 4½ Cents a Foot.

By Richard B. Moore
Dean of Science, Purdue University, Formerly in Charge of Helium Work for the U. S. Bureau of Mines

Many readers of The Oil and Gas Journal have seen either the Los Angeles or the Shenandoah floating in the air above them. They have seen these ships traveling at a speed of 60 or 70 miles an hour, gleaming in the sunlight as though made of silver. They have probably heard that these airships were filled with helium and that the use of this gas made their operation very much safer than it otherwise would be. They probably do not know, however, that if it were not for this noninflammable gas these two giants of the air would never have been built; in other words, the availability of helium to American aviation has made it possible for us to have airships because Congress very definitely took the attitude that without the safety accorded by helium money would not be appropriated for airships.

What is this gas which has suddenly become so important? This is a justifiable question and deserves a definite answer. The present article will try and give an answer to the question.

In 1868 there was an eclipse of the sun which could be observed best in India. An astronomer named Janssen for the first time used a spectroscope during an eclipse. The spectroscope was pointed at the chromosphere which represents the "atmosphere" immediately surrounding the main portion of the sun to a depth of about 10,000 miles. He observed a brilliant yellow line and made a permanent record of this line by taking a photograph of it. The next year, Sir Norman Locker, a British astronomer, measured the wave length of this line and announced that it belonged to an element which had not been discovered on the earth. He named it helium from the Greek word "helios," meaning sun.

Terrestrial Helium

For many years no further knowledge was obtained concerning the new element. The next chapter in the drama opens in 1894, nearly 30 years later. In that year Sir William Ramsay, the English chemist, and Lord Rayleigh, the English physicist, announced the discovery of argon in the atmosphere. Following this discovery, Ramsay sought for new sources of argon. He heard that Doctor Hillebrand, who was then chief chemist of the United States Geological Survey, had obtained gases from certain minerals which consisted partly of nitrogen. Ramsay thought that perhaps part of the so-called nitrogen might be helium. He, therefore, wrote to Hillebrand and asked for a specimen of one of the minerals and the American chemist sent him a sample of the uranium mineral called clevite. Ramsay obtained some gas from this mineral and after purification he ran the residue into a spectrum tube and examined it with a spectroscope. To his surprise he did not get an argon spectrum but obtained a bright yellow line with other lines in the red and green. This was a different spectrum to any which he had previously observed and he took a photograph of it and sent it to Sir William Crookes, the English spectroscopist. A few days later Crookes reported that the spectrum corresponded to that observed by Janssen in the chromosphere of the sun in 1868 and that Ramsay therefore had discovered terrestrial helium.

This tremendously important discovery, coupled with that of argon, led to the discovery of three other gases, all of which exist in the atmosphere, namely, Neon, Krypton and Xenon, the latter two gases being in the air in infinitesimal quantities, Krypton one part in 19,000,000 and Xenon one part in 190,000,000. For many years helium was a scientific curiosity, small quantities of which were used by scientists for research work. It had no practical use and at the opening of the World War there was probably no more than 10 cubic feet in existence.

Worth $1,500 Cubic Foot

Therefore, when it was suggested in 1917, a few days after we entered the war, that helium should be put in airships instead of hydrogen, the suggestion was at first received not only with skepticism but almost with amazement. A foreign chemist later expressed the general view of the scientific public by saying that the idea was somewhat like trying to cover the Washington Monument with diamonds. Helium at that time was worth not less than $1,500 a cubic foot and as a dirigible had a capacity of at least 2,000,000 cubic feet, the whole thing looked impractical as it would have cost $3,000,000,000 to supply one dirigible.

And yet this was not so because helium had been found to exist in certain natural gases in the United States in appreciable quantities. Some natural gas in Texas, Oklahoma and Kansas contained the rare gas in quantities of 1 per cent and in a few cases, almost 2 per cent. This made available a potential source of the gas that did not exist before. The fact that helium is absolutely noninflammable and does not explode when mixed with air or oxygen in any proportion gave it a value which made a reasonable expenditure of money on research thoroughly justified. The result was that Congress made appropriations to the Army and Navy for experimental and research work and under the direction of the United States Bureau of Mines and with the cooperation of the Linde Air Products Co. and the Air Reduction Sales Co. experimental plants were constructed which resulted in the large commercial plant which is now situated at Fort Worth. This plant when running at full capacity can produce over 1,000,000 cubic feet of helium per month using the gas from the Petrolia Field. Unfortunately, this gas field has been running down rapidly during the last few years and is unable to supply enough gas for the plant to run at full capacity. The result has been that the Army and Navy have been somewhat cramped in their lighter-than-air operations due to the lack of helium.

Liquefying Gases

All gases can be liquefied if a low enough temperature is reached and sufficient pressure is used. Under these conditions air, hydrogen, and even helium can be liquefied, but helium is the most difficult of all gases to obtain in the liquid state. This property gives the clue to the production of helium from natural gas because if everything else in the natural gas can be liquefied first the helium can then be pumped off and successfully separated in this way. This is the method which was used in the experimental plants and is used today. With a liquid air plant as a basis, new designs have been worked out which make it possible to liquefy the propane, butane, ethane, methane and nitrogen in the gas, leaving the helium unliquefied. The helium is accompanied by about 50 per cent of its volume of unliquefied nitrogen. This impure helium is repurified by reducing it to the temperature of liquid nitrogen at a pressure of over 1,000 pounds. Most of the nitrogen under these conditions is liquefied and the helium obtained is about 93 per cent or 94 per cent pure and is available for use in airships.

It can be seen from this outline of the process used that a high degree of skill and experience is required and whereas helium can now be produced without any trouble, it can only be done successfully under proper conditions.

Wide Distribution

Helium is not found in all samples of natural gas but is, nevertheless, widely distributed in the natural gas of this country. Up to recently there were only two or three known localities in Canada where the natural gas contained helium in quantities that would pay for commercial extraction. Recently, however, the Department of Mines of Canada has published a monograph[1] which shows that the Canadian Government has been fully aware of the importance of the rare gas both for war purposes and for commerce. A considerable number of gas samples have been analyzed and almost invariably they contain traces of helium. Only a few samples contain over .4 per cent and only four or five were above .5 per cent. Unfortunately, some of the richest gas is only found in small quantities. The Department of Mines estimates that the amount of helium recoverable per annum is as follows:

Field	Helium recoverable per annum cu. ft.
Foremost, Alta.	2,000,000
Bow Island, Alta.	1,250,000
Norfolk County, Ont.	900,000
Haldimand, County, Ont.	275,000
Haldimand, County, Ont.	540,000
Peel County, Ont.	200,000
Total	5,165,000

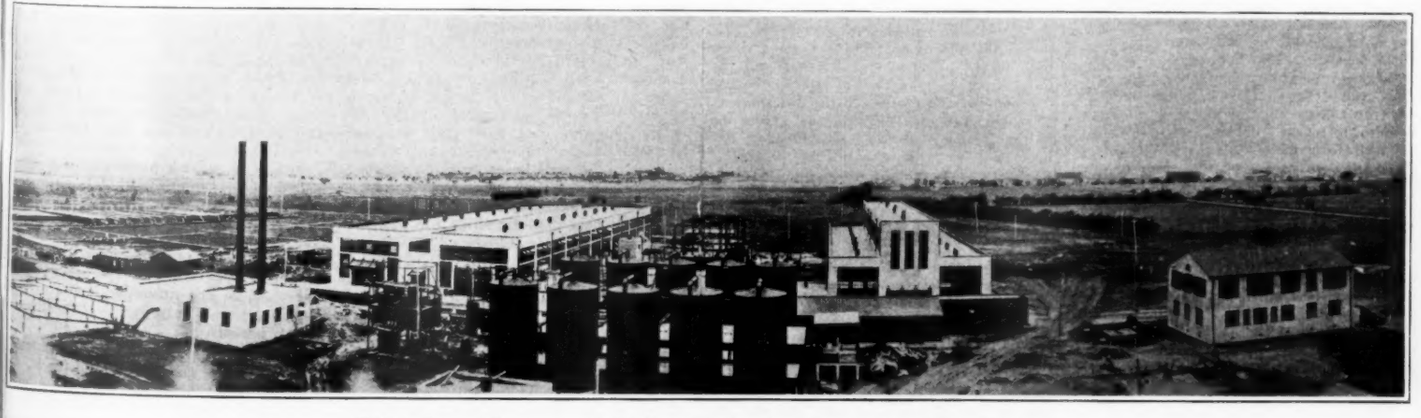
Larger Supply in U. S.

It probably would be impractical from the cost point of view to get this total production but it would undoubtedly be possible to get 2,000,000 or 3,000,000 cubic feet of helium per annum if it were necessary.

Although this quantity of gas appears to be large, it is small compared with the available supply in the United States. The Bureau of Mines has analyzed several thousand samples of natural gas. Practically every known gas field in the United States has been tested and the Government is fully aware just where the best supplies of helium-bearing gas are situated. A preliminary report was published by the United States Geological Survey in 1921[2]. Owing to the importance of the whole subject from the national defense point of view, no further detailed information has been given out or is available at the present time. However, some generalities are permissible. Most of the natural gas in this country contains traces of helium, the larger number of samples from .1 per cent to .5 per cent. At the present time, a gas is considered as being "commercial" if it contains .5 per cent or more. The number of samples that fall in this category is relatively small but the volume of gas available is extremely large. Later on when improved methods of extraction are developed so that the cost of production is still further lowered, gas containing .4 per cent helium, or even .3 per cent helium may be considered commercial and when this is true, a very large additional amount of gas will be available for helium extraction. The gas in the Petrolia Field from which the Government is obtaining its supply contains approximately 1 per cent helium. A few gas fields carry as

[1] "Helium in Canada" by R. T. Elworthy, 1926.

[2] "Helium-Bearing Natural Gas" by G. Sherburne Rogers, 1921.



United States Government's Helium Production Plant at Fort Worth, Tex.

high as 1½ per cent. In general, the helium-bearing zone starts in Texas, goes up through Oklahoma, southeastern Kansas, Indiana, Ohio, Pennsylvania and New York, coming back through West Virginia and Kentucky. The best fields are in Texas, Oklahoma and Kansas, the eastern gas fields usually running from a trace of helium up to .3 per cent. One gas field in the United States contains enough helium-bearing natural gas to fill 200 dirigibles of the size of the Los Angeles and keep them in the air for five years, provided all of the gas in the field was processed. In case of necessity, it would not be impractical to produce 100,000,000 cubic feet of helium per annum or more. It can therefore be seen that the whole question of the use of helium in airships is quite practical.

Distribution Here

The following table gives some idea of the distribution of helium in the United States. The large Wyoming and California fields are largely barren, as already stated, the richest gas being found in the central states.

Helium in Natural Gas (per cent)

No. of counties sampled	Highest Per cent	Lowest Per cent	Average Per cent
(1)	(2)	(3)	(4)
3	0 26	Trace	0 13
7	0 11	None	None
5	1 04	None	0.20
2	0 12	0 04	0 08
9	0 61	0.11	0 34
17	2.13	Trace	0 76
15	0.43	None	0 15
9	0 19	None	0 04
2	0 04	None	0 02
4	0 27	0.01	0 08
1	Trace	Trace	Trace
13	0 31	None	0 11
1	0 17	0.17	0 17
15	0 55	None	0 30
24	1 04	Trace	0.23
10	0 17	None	0 07
2	0 04	Trace	0.03
1	0 36	0.35	0 35
26	1 73	None	0 43
2	Trace	None	..
3	0 12	None	0 05
2	0 06	Trace	0.03
10	0 10	Trace	0 01

Column 1 gives the number of counties in 23 states in which natural gas samples were examined for their helium content. As in some of these states, samples were taken from more than 15 counties, and in many of the individual counties a large number of samples were examined, it can readily be seen how widely distributed helium is in our natural gas and what a tremendous volume of the rare gas could be obtained from this source.

Fort Worth Plant

The Fort Worth plant has a capacity of about 150,000,000 cubic feet of natural gas per month. Lately, the gas received from the Petrolia Field has been not more than 50,000,000 or 60,000,000 cubic feet per month. This situation has become so serious that the operations of the Army and Navy have been greatly interfered with. The Navy needs 6,000,000 cubic feet of helium per year and the Army needs 4,000,000 cubic feet. Under favorable conditions the plant at Fort Worth can easily produce this amount but during the present fiscal year, owing to lack of gas, there will be a shortage of at least 4,000,000 or 5,000,000 cubic feet of helium. The need for additional gas has been known for years but it has not been possible to get Congress to act until recently. The last session of Congress appropriated $1,063,000. for pipe lines and other purposes which will go towards taking care of the gas shortage. Something over $500,000 will probably be used to connect up the Government pipe line, which goes from the Petrolia Field to Fort Worth, to the Nocona Field. This should give an adequate supply of gas to the Fort Worth plant for eight or ten years provided the local demands on the Nocona Field are not too great and the Government can process a reasonable percentage of the gas. The percentage of helium in this field is about the same as that in the Petrolia gas and the gas in every other way is favorable for treatment.

Origin of Helium

The origin of helium in natural gas is of great interest. There are two possible theories: The first that helium is of primordial origin, being one of the original elements of which the earth is composed. It may have been acquired from the sun if we assume the nebular hypothesis. The theory is that all the helium, both in natural gas and in the atmosphere, has been derived from the radium in the earth's crust. It is well known that the alpha particle which is given off in radio-active changes is a charged helium atom and helium is therefore a product of radio-active change. A difficulty in connection with this theory is that whereas all rocks composing the earth's crust contain small traces of radium and thorium, we would have to assume the diffusion of the helium through several miles of the earth's crust in order to get a concentration of helium such as is found in a field like the Petrolia or Nocona Fields. We know that a large percentage of the helium produced in a radio-active mineral is retained in the mineral even though the specimen weighs only a few ounces. It is therefore difficult to believe that any appreciable quantity of the gas can diffuse long distances through the earth's crust in localities made up largely of igneous rock. The sedimentaries have a smaller radium content but furnish facilities for more rapid diffusion. The whole matter is one which is being studied and no definite explanation can be given at the present time.

Cost of Production

A study of the cost of producing helium affords an excellent illustration of the value of industrial research. When the rare gas was first produced in one of the experimental plants during the war, it cost over $500 a cubic foot. This was ultimately cut to $300 and even $250. In the production plant, which is now operating, the cost for some time was over $100. It was then cut to $75 and finally to $40. When the plant is operating at full capacity and under favorable conditions, helium can be produced for $25 per 1,000 cubic feet. The operating costs include the expense of operation and repair at the plant, the administrative overhead at the plant and the administrative overhead in Washington. They do not include any charges for research, depreciation and amortization or new construction and plant improvements. If the supply of gas is curtailed, the costs mount rapidly. With the production of 600,000 cubic feet of helium per month instead of 1,200,000, the costs are about $40 per 1,000 instead of $25. It is, therefore, extremely important to keep the plant going at full capacity even if we do not take into consideration the inconvenience caused the Army and Navy in their airship operations.

Helium once used in an airship becomes contaminated with air. This is due to the diffusion of air into the envelope and at the same time some of the helium diffuses into the atmosphere. When hydrogen was used, the gas ultimately had to be completely discarded as it is not practical to purify hydrogen from air which has diffused into it. This, however, can be readily done with helium. The Navy has a repurification plant at Lakehurst, the home of the Los Angeles, which can repurify the helium used in the Los Angeles at a cost of about $2 per 1,000 cubic feet. The general principle of purification is quite similar to that used in the initial extraction of helium from natural gas. The impure helium containing about 15 per cent air is compressed to 2,000 pounds and run through a "purifier" immersed in a bath of liquid air. At the temperature of liquid air and at a pressure of 2,000 pounds the oxygen and nitrogen in the helium are liquefied and the purified helium passes on as gas. In this manner the purity is raised to nearly 99 per cent.

Repurification Cuts Cost

Repurification greatly reduces the total cost of helium as compared with hydrogen. The "refill" with hydrogen is normally about 2,000 per cent per annum. Putting the cost of hydrogen at $5 per 1,000 cubic feet which is cheaper than it is usually produced for, and with a refill of 2,000 per cent, the relative cost of hydrogen would be $105. With helium at $25 per 1,000 and a refill of 200 per cent the relative cost of helium would be $75. The Army and Navy do not require quite 200 per cent refill in connection with their present operations although if the supply of helium was plentiful they would probably use that much. The gas is mainly lost by valving although a portion of it is lost by diffusion. It can therefore be readily seen that helium is actually no more costly than hydrogen for airship operations.

It is not possible in an article of this kind to do more than merely touch on the development and future use of airships and yet this represents the main use for helium at the present time. Up to the war, all airship developments were carried on in Germany; during the war, England, France and Italy got into the game; since the war, most of the development connected with rigid airships has been carried on in this country. Indeed it is probable that had it not been for the construction of the Shenandoah there would have been little or no progress in lighter-than-air ships for perhaps a decade.

At the present time, the English have two large rigids under construction for use between England and the Far East. These have a capacity of 5,000,000 cubic feet or twice that of the Los Angeles with a length of 800 feet and a maximum diameter of 110 feet. It is expected that these giants of the air will reach lower Egypt in two days and Australia in ten days. Since the British do not possess any adequate supply of helium, these vessels will be filled with hydrogen and will be able to carry over 40 tons of useful load with an operating range of 3,000 miles fully loaded. In war time, by carrying less freight and more fuel, it would be possible for them to have a range of action of 15,000 miles. When the "useful" lift is taken into consideration (the lift in addition to the weight of the airship itself) the foregoing figures for hydrogen would have to be reduced between 20 per cent and 25 per cent for helium. It is expected that these airships will carry 120 people.

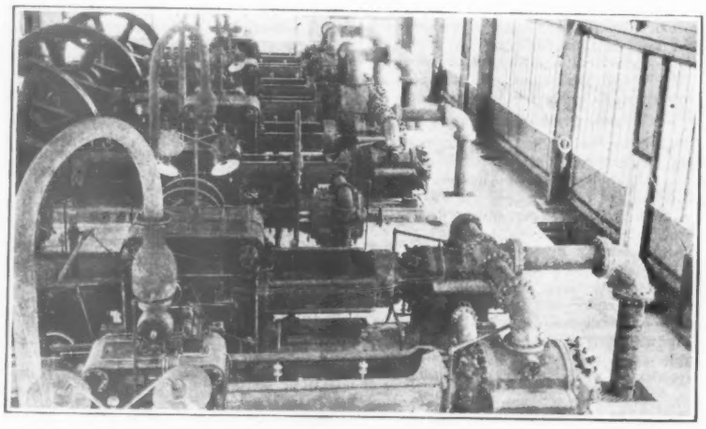
Value to Owner of Gas

Readers of The Oil and Gas Journal are naturally interested in knowing what value helium in natural gas has to the owner of the gas. The Government does not pay the Lone Star Gas Co. for the helium which it abstracts from the gas; it simply pays for the gas which is used under a contract with the company at a definite rate. From 3 per cent to 5 per cent of the gas that goes through the plant is lost due to leakage, etc., 1 per cent, viz. helium, is taken from the gas and 25 per cent or 30 per cent of the residue is used for power purposes. All of this is paid for at a definite rate but the helium itself is not purchased. Therefore, helium in natural gas cannot be looked upon as a gold mine for the owner of the gas. Large fields, however, containing a high percentage of helium give that gas a potential value for the future, not in connection with the sale of the helium itself but in connection with the sale of the gas or field. In other words, if the Government or some commercial agency is looking for a high helium gas, such a gas might get a favorable market when it could not be sold to advantage without the helium.

Owing to the fact that the plant at Fort Worth has not been able to run at full capacity during the past year the Navy has asked for bids on a certain volume of helium to be produced within the next few months. In the opinion of the writer it is not possible for a commercial organization at the present time to undertake the production of helium unless a definite contract can be obtained from the Government under terms which we know the Government cannot carry out. The Government cannot make a contract for more than one year and if the Government is the only user at the present time a commercial company could not make plans for more than one year. A company would, therefore, have to take a chance on the contract being renewed and in order to protect itself it would be necessary to charge a price which the Government could probably compete with. In other words, the present time is not a favorable one for the commercial production of helium. If a commercial airship company were in existence the situation would be quite different and if other uses for helium arise which will result in a steady demand, an excess amount could be produced for sale to the Government during any given year. Therefore, for the present the Government should extract its own helium, even though it involves the control of leases, the laying of pipe lines, the drilling of wells, etc. in addition to the extraction of helium. For the sake of the national defense, some large field should be acquired by the Government and the gas held in the ground for future emergencies. The only safe way of storing helium for any length of time is in the ground before extraction. All other means involve high pressures and therefore a certain amount of leakage. The Army and Navy have storage for over 20,000,000 cubic feet of gas but this involves a larger number of cylinders besides the airships themselves and such storage is only practical for relative short periods.

Wherever there is a supply of material, sooner or later uses are found for it, and undoubtedly additional uses will be found for helium besides those which are known at the present time.

NATURAL GAS COMPRESSOR STATION



Expensive machinery is required to increase the pressure of natural gas, when it comes from the field in order that it might be transported long distances to consumers.

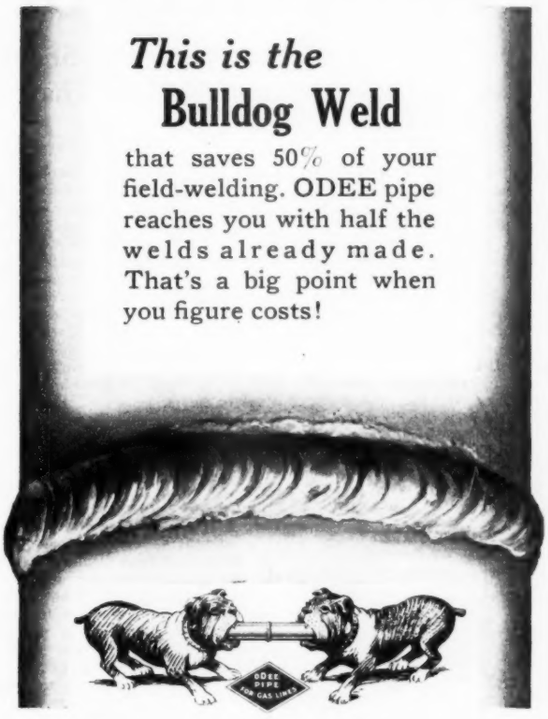
50-50

we weld half, you weld half

And you make all the saving. ODEE pipe is furnished in double lengths with the ends cut smooth and beveled for perfect joints—reduces field-welding almost 50%. It carries our guarantee of utmost service, at prices that save you 1/3 or more. With a reasonable down-payment, the line can be financed out of income.

These are a few reasons for the popularity of ODEE Pipe for Gas Lines. It is more and more recognized as standard practice where speed and economy are essential. Write, wire or 'phone for quotations.

Jos. GREENSPON'S Sons
IRON & STEEL COMPANY
Main Office: St. Louis, Mo.
Branches: Tulsa and Fort Worth.



This is the
Bulldog Weld
that saves 50% of your field-welding. ODEE pipe reaches you with half the welds already made. That's a big point when you figure costs!

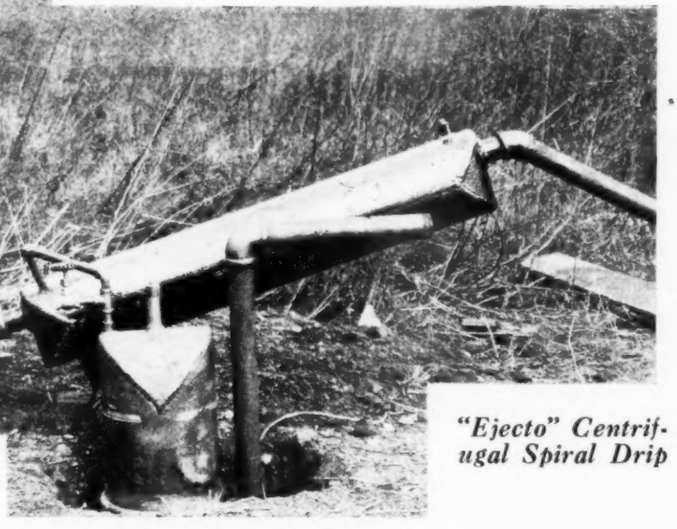
ODEE Pipe for Gas Lines!

"Ejecto" Well Tubing

"EJECTO WELL TUBING." **Taking liquid off the sand with the gas, without working barrels, rods or pumping outfit.**

"EJECTO CENTRIFUGAL SPIRAL DRIP." **Separating the liquids from the gas—without waste of gas or liquids.**

"EJECTO AUTOMATIC VALVES." **Passes the liquid from the Drip to overflow or storage.**



"Ejecto" Centrifugal Spiral Drip

"Ejecto" Automatic Valve

THE "EJECTO" COMPANY, Keith Building, Cincinnati, Ohio

Development of Absorption Method

Plant Operations Should Be Based on Dollars and Cents Income Rather Than Gallons of Gasoline Production

By C. C. Reed
Assistant General Superintendent, Hope Natural Gas Co.

The absorption gasoline industry began in a very small way at first progressed slowly. Starting with not much more than an idea, experiments were made at Hastings, W. Va., in 1906, under the direction of Roger Chew. The same year George M. Saybolt applied for letters of patent which were granted in 1911. On account of the low price of gasoline at that time, experimental work was discontinued until 1913.

In February, 1913, an experimental plant was built by the Hope Natural Gas Co. at Hastings, W. Va., and work was again started under the direction of Roger Chew, with C. C. Reed as assistant. The plant at this time was composed of one horizontal absorber, 30 inches by 76 feet which could also be used

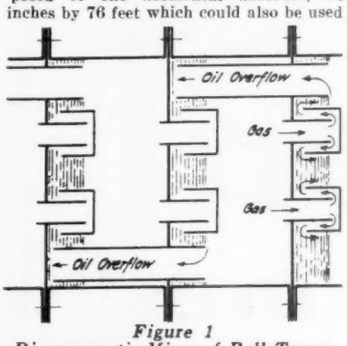


Figure 1
Diagrammatic View of Bell Tower

as a still, since the apparatus was operated on the "batch" principle. Several vertical stills of 10-inch pipe were also available. The gas was dry natural gas, on its way to market. It is hard to tell what the actual gasoline content may have been. Yields were obtained from 74 gallons per 1,000,000 feet of gas up to 275 gallons per 1,000,000. The pressures ranged from 110 pounds gauge to 314 pounds gauge.

In the summer of 1913, the commercial plant at Hastings, W. Va., was constructed, to treat the gas discharged from Hastings pump station, and was put in operation in September of that year. There was no radical difference between the plant as then constructed and modern plants, except in the design and type of the component parts, and in the fact that it was not provided with a vent tank. As first operated, this plant was not a success and made no real progress until the venting apparatus was installed later.

Details of Design

Since the Hastings plant was the first one ever constructed, it may be of interest to mention a few of the details of design. The absorption system consisted of thirty 30-inch by 80-foot horizontal absorbers in parallel, into each of which gas and oil were introduced at four places. These absorbers had a capacity of approximately 150,000,000 cubic feet in 24 hours, at 300 pounds pressure. The still was a 10-foot by 30-foot standard refinery steam still, with a 5-foot by 30-foot stone tower filled with cobblestones. The condenser was the submerged type of the usual refinery construction. The gasoline from this plant was not looked upon favorably by the refineries at that time, and rightly so, as the quality was not to be compared with modern absorption gasoline.

Development in gasoline absorption plant practice was slow for several years. Gradually, changes in design of equipment have taken place. The original horizontal absorbers were supplemented by spray absorbers, in which absorption oil was sprayed into a body of gas. These are still in use at many plants. Then came the vertical absorber, packed with most anything that suggested itself to the fancy of the designer. Spiral acid rings were, and still are, the popular choice. The latest development has been in the use of the bell or bubble tower, which has many advantages. In this type, oil is introduced into the top of a vertical tower, which is divided by a number of horizontal plates, equipped with bell caps as shown in Figure 1. The gas enters at bottom and ascends. In this type, it is impossible for the descending oil to channel, that is, to descend by one path while the gas ascends by another.

Later Improvements

In absorption plant steam still design, there have been many changes. The first stills used were refinery steam stills. Later the towers were omitted, and finally a complete reversal took place and the kettle or tank was discarded and the tower only used, a much more economical arrangement. The latest practice is to use bell towers for this purpose. The higher cost is probably the reason this type was not used earlier on absorption plants, since the bell, or bubble tower, has been in use for years in various industrial processes, and has proven satisfactory.

Condensers of all kinds are used, and each type has its adherents. Many of factory manufacture are on the market, the most popular being the shell and tube type. Numerous types of heat exchangers have been proposed and are on the market, but the double pipe type, when equipped with properly designed, welded, expansion heads, will give the best all-around satisfaction.

Automatic appliances have played a large part in the economical operation of gasoline plants. Automatic boiler controls have been on the market for years,

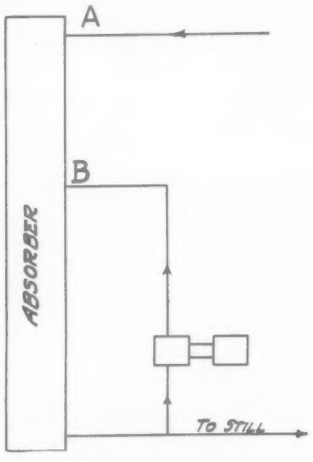


FIG. 2.

as have also temperature controls, which are used on stills and expansion boxes. Level controls for gasoline plants were largely developed to satisfy the demand.

Lack Scientific Data

The industry has been, and still is, hampered by a lack of scientific and mathematical data in connection with absorption plants. In the early development of the process, there was no bibliography. Publications of the Bureau of Mines appeared in the course of time, to be followed later by the works of individuals. There is sometimes a great discrepancy between theory and practice due largely to incomplete theory and inefficient apparatus. As an example, from theoretical considerations, a vertical absorber packed with acid rings requires, when operating on dry natural gas at 300 pounds pressure, about 2.3 gallons of oil per 1,000 feet of gas treated. Actually seven gallons are required, and even

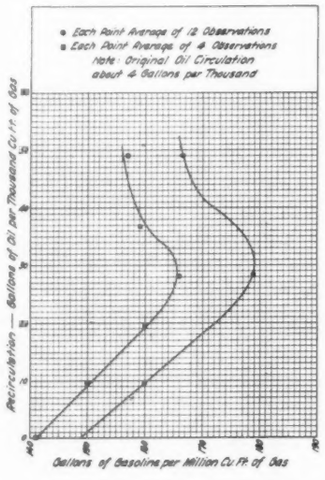

Each Point Average of 12 Observations
Each Point Average of 4 Observations
Note: Original Oil Circulation about 4 Gallons per Thousand
Recirculation — Gallons of Oil per Thousand Cu. Ft. of Gas
Gallons of Gasoline per Million Cu. Ft. of Gas

FIG. 3

then the outlet gas may show considerable gasoline content. An investigation of this type of absorber reveals the fact that when of sufficient diameter to prevent oil from carrying over, there is so great a cross section that the oil does not spread over all the rings, consequently there is channeling, and an excess of oil over theoretical requirements is necessary. As an experiment, a 20-inch by 56-foot ring packed vertical absorber was connected as shown in Figure II. Oil from the still was introduced as shown at A, at a rate of 4 gallons per 1,000 feet of gas and after dropping through the absorber, was reintroduced at a lower point B, at various rates, with the results as shown in Figure III. Approximately 20 per cent increase in gallons of gasoline resulted from a recirculation of 30 gallons of oil per 1,000, after which there was a decrease, probably due to the fact that there was so much oil that it flowed in streams, rather than thin sheets, and did not properly come in contact with the gas. An interesting experiment might be performed, using an absorber having a relatively small diameter absorbing section, and an upper section of sufficient diameter to separate the absorbent oil from the gas. There are many cases in absorption plant operation, where different operations on the absorbent oil, in different parts of a plant, are dependent on each other. For example, in a certain absorber, 8 gallons of oil were being circulated per 1,000 feet of gas. The valve A, in Figure 4, was then partly opened, and a part of the discharge from the pump, whose speed was not changed, was bypassed around the absorber, and into the oil on its way to a low-pressure vent tank. There was no appreciable decrease in production until the bypassed oil was nearly 50 per cent of the total. The explanation is that an excess of oil was used in this particular type of absorber, over the amount necessary for absorption, but that this excess was later necessary to hold the absorbed gasoline vapors when the pressure was reduced for venting. This may readily be understood when we consider the fact that theoretically, the ratio of the oil required to absorb pentane, at 15 pounds absolute to that required at 300 pounds is approximately 20 to 1.

The absorption plant as usually constructed is not financially profitable for small gasoline production. Operating charges, such as labor and fuel, sometimes cannot be brought down to a point where the operation is profitable. Plants are in operation, however, designed for low operating cost rather than efficiency, which have proven satisfactory.

In the early development of the gasoline plants, equipment of all kinds was included in plant design to increase production. The tendency now is towards simplification, which reduces investment and operating charges. Gasoline plant operation should be based on dollars and cents income rather than on gallons of gasoline production. Most plants are found to be more profitable financially when no attempt is made to remove the last vestige of gasoline from the gas. The last few gallons per 1,000,000 feet are generally obtained only at a prohibitive cost per gallon.

An extreme example of a profitable low-efficiency plant, is a small absorption plant which is being operated on dry natural gas, and whose efficiency is about 40 per cent. The plant was designed on the thermo siphon principle of circulation, as an experiment, and contains no pumps or machinery, and has no operating crew. This plant produces only about 70 gallons per day, but is making a fair return on the investment.

Owing to the present overproduction, progress in the absorption gasoline industry, for the present, will no doubt be in the direction of operating economy. The plant of the future will be as simple as possible in construction, with units designed to give the greatest possible efficiency.

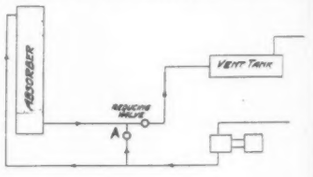


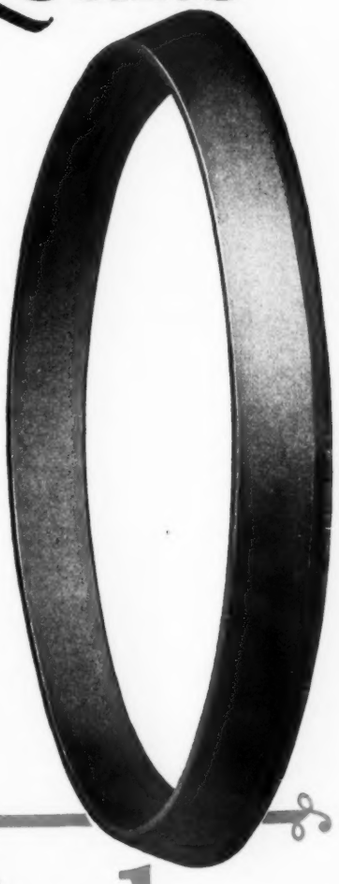
FIG. 4.

DEEP AND DRY

Hazards of drilling for natural gas are emphasized in the instance of the Lake well of the Hope Natural Gas Co. in West Virginia, shown above. It was drilled to a depth of 7,679 feet and was dry.

Your Best Insurance Against Leaks

Grade "19"



The disastrous waste of gas which may result from a single leak is pointed out in a recent article by E. L. Rawlins of the Bureau of Mines.

In one extreme case, a single bad coupling leak was losing gas at the rate of $19,690 per year—emphatic proof that it pays to take no chances in selecting coupling rubbers for *your* line!

Specify Goodrich Grade "19".

THE B. F. GOODRICH RUBBER CO.
Established 1870 Akron, Ohio

Goodrich
GRADE "19"
COUPLING RUBBERS

Gasoline Recovery From Natural Gas

Permits Companies to Provide Better Fuel and Eliminates Losses and Interruptions to Service

By Dr. J. B. Garner
Director Chemical and Engineering Research, Hope Natural Gas Co. and Affiliated Companies

When the first gasoline plant had been installed and successfully operated for the removal of gasoline from the large commercial supplies of natural gas, some ingenious soul originated the idea that in recovering the gasoline from natural gas "all of the heat and pep of the gas were removed." The natural gas industry was accused of skimming the cream from the whole milk and endeavoring to serve the public with the substitute—skimmed milk. This fanciful thought had a cordial reception in the minds of the general public and before the natural gas gasoline industry was out of its swaddling clothes, that which was in the beginning fancy had transformed itself into fact. Happily, as time has gone on, the public has had opportunity to receive dependable and accurate information on the subject. A reaction has taken place and the public now generally approves of the natural gas industry's uninterrupted service of a clean and refined natural gas. It is gratifying to leaders of the industry that such a condition of understanding, toleration and good will exists in the public's mind. The reasons for this are not far to seek. On the one hand, the industry and various governmental departments have joined hands in securing and publishing very complete information for the use of the public; on the other hand, the public has been openminded and it has been proved to it that natural gas service has been so improved that natural gas is generally acclaimed as the cleanest, most economical and most dependable supply of domestic fuel.

Great economic changes have been wrought during the past ten years. The development of the internal combustion engine has occasioned a demand for motor fuel of such amazing proportions that nature has been subjected to close examination for potential supplies. The natural gas industry responded to the demands of this great industrial age and produced natural gas gasoline. The invention of sanitary and labor-saving devices for the home has relieved women of the old-time drudgeries. The natural gas industry has played its heroic part in its contributions to the welfare and comfort of thousands of homes.

Much Research Done

In order that the gas-consuming public may fully appreciate and clearly understand the results of removing gasoline from natural gas, the following are presented:

1. Much research work on this subject has been done. The results of these investigations have been published in scientific journals and books and are hence available should the public desire details of experimentation, methods of procedure, etc. Particular reference is made at this time to the following publications:

(a) Technical Paper No. 253, United States Bureau of Mines, entitled "Effect of Gasoline Removal on the Heating Value of Natural Gas" by Donald B. Dow;
(b) Natural Gasoline by G. G. Oberfell and R. C. Alden, pages 80 and 81;
(c) Handbook of the Petroleum Industry, by David T. Day, volume 1, pages 752 to 757; and
(d) Articles by Dr. R. P. Anderson in the Journal of Industrial and Engineering Chemistry, June and September numbers, 1920.

2. Simple arithmetical calculations have been made, based on the results of the investigations cited. The purpose of these calculations is to show exactly the effect of removal of gasoline from natural gas on (a) its volume, (b) its heating value, and (c) its specific gravity. In making these calculations, data relative to volume of natural gas treated and quantity of gasoline extracted therefrom have been taken from the Bureau of Mines publications entitled (a) Natural Gas in 1924, and (b) Natural Gas Gasoline in 1924.

Data Generally Accepted

The following tabulation, taken from one of the articles by Dr. R. P. Anderson, contains data which have general acceptance in scientific and technical circles:

1 Gravity °Baume Gasoline	2 Probable Specific Gravity of Vapor
90	2.63
85	2.84
80	3.07
75	3.38

In column 1 are given the Baume gravities of the gasoline recovered from the natural gas; in column 2 are contained the probable specific gravities of the gasoline vapors removed from the gas; in column 3 are given the probable gross heating values, B.t.u. per cubic foot at 60 degrees Fahrenheit and 30 inches mercury, dry; and in column 4 are given the probable volumes of vapor in cubic feet required to produce one gallon of the different grades of gasoline.

By way of example, it may be stated, as a matter of experimentation, that one gallon of natural gas gasoline, gravity 90 degrees Baume, is made up of 26.4 cubic feet of gasoline vapor and that one cubic foot of this vapor has a gross heating value of 4,278 B.t.u. per cubic foot, and a specific gravity of 2.63 (air=1).

Natural gas, as it is commercially produced and distributed in the states of West Virginia, Pennsylvania, Ohio, Kentucky and Louisiana, is typically representative of our American supply. According to "Natural Gas in 1924," these states produced 44.7 per cent and consumed 43.8 per cent of the total volume of natural gas treated for gasoline recovery in the year 1924. According to figures contained in "Natural Gas Gasoline in 1924," the average weighted yield of gasoline recovered from the natural gas of these states was 350 gallons per million cubic feet of raw gas.

3 Probable Heating Value B.t.u. per Cubic Foot	4 Probable Volume Vapor per Gallon, Cubic Feet
4278	26.4
4574	25.1
4933	23.7
5416	22.1

During the past 10 years the writer has studied the problems of efficient operation of oil absorption and charcoal adsorption plants for the recovery of gasoline. One of the large plants in West Virginia has been the subject of considerable study. The quality of the gas treated at this plant is such that the average yield of gasoline, gravity 90 degrees Baume, obtained is 350 gallons per million cubic feet of gas treated. The following are the results of an analysis of this gas on March 1, 1927, according to the proximate method of gas analysis:

	Per Cent
Carbon dioxide	0.1
Methane	79.0
"Ethane"	20.4
"Propane and higher hydrocarbons"	0.4
Nitrogen	0.1
	100.0

Calculated gross heating value per cubic foot at 60 degrees Fahrenheit and 30 inches mercury—dry—1,167 B.t.u.

Calculated specific gravity — (air=1) at 60 degrees Fahrenheit and 30 inches mercury—dry—0.6588.

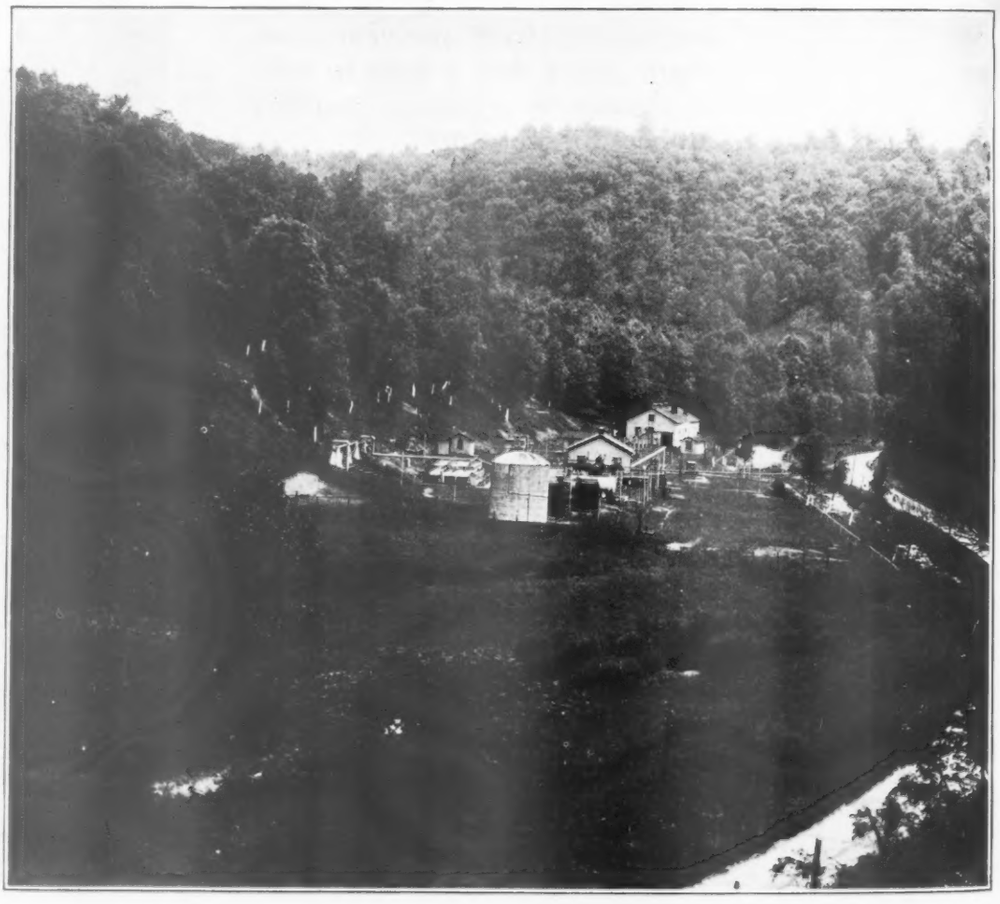
Loss in Volume

A quantity of 350 gallons of gasoline requires 350 by 26.4 or 9,250 cubic feet of vapor. This volume of vapor taken from 1,000,000 cubic feet of natural gas is 0.925 of 1 per cent or the volume loss is less than 1 per cent. The residual gas for delivery to market is 991,750 cubic feet.

Loss in Heating Value

The heating value of any sample of gas is designated by its content of British thermal units. A British thermal unit, abbreviated as B.t.u., is the amount of heat required to raise the temperature of one pound (avoirdupois) of water through 1 degree Fahrenheit. There are 9,250 cubic feet of vapor of a heating value of 4,278 B.t.u. per cubic foot w-

NATURAL GAS GASOLINE PLANT AMONG THE HILLS

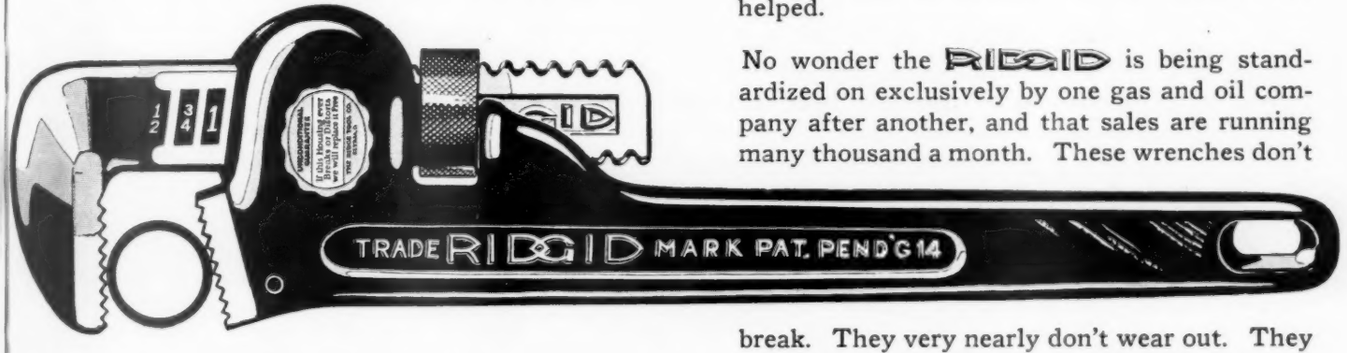


The "Hundred Gasoline Plant" of the Pittsburgh and West Virginia Gas Co., located in West Virginia.

Here's Ralph Ash, driller for Clark & McDougal, Contractors, Henryetta, Okla., and Stanley Chatham, his helper. They say the RIGID is the best pipe wrench they ever used.

ONLY an extraordinary pipe wrench could have come into the Oil Industry and won the enthusiastic approval the RIGID has gained in less than a year. Pipe wrenches were an old story to gas and oil men. They bought them, they busted them, they replaced them. Expense and annoyance—but it couldn't be helped.

No wonder the RIGID is being standardized on exclusively by one gas and oil company after another, and that sales are running many thousand a month. These wrenches don't break. They very nearly don't wear out. They cut expense to a fraction of what it was and remove all the annoyance.



There Never was Such a Pipe Wrench Before!

AND HERE ARE 8 REASONS WHY:

You can't lock a RIGID on the pipe.

You can't break or distort the housing.

Hook jaw won't break or bend.

Nut, protected by housing, is wide open, always easy to adjust.

Powerful I-beam handle, comfortable grip.

Handy hang-up hole in handle.

Pipe-size scale on jaw.

Made in End pattern for tight places.

If you haven't tried a RIGID yet, you're missing the tool sensation of the year. Ask your Supply Store or Jobber.

THE RIDGE TOOL CO., DEPT. O, ELYRIA, OHIO

RIGID

PIPE WRENCHES
VISES AND PIPE CUTTERS

WRENCHES

McCord Force Feed Standard

Buy Lubricators for your compressors, pumps and engines on the basis of tried and proven performances, and you will buy McCords. More McCord Lubricators are in use in the oil fields than all the other makes combined. This preference is merited by McCord Lubricator dependability, accessibility and economy.

McCord Dependable Lubricators keep operating costs at a minimum and insure uninterrupted production.

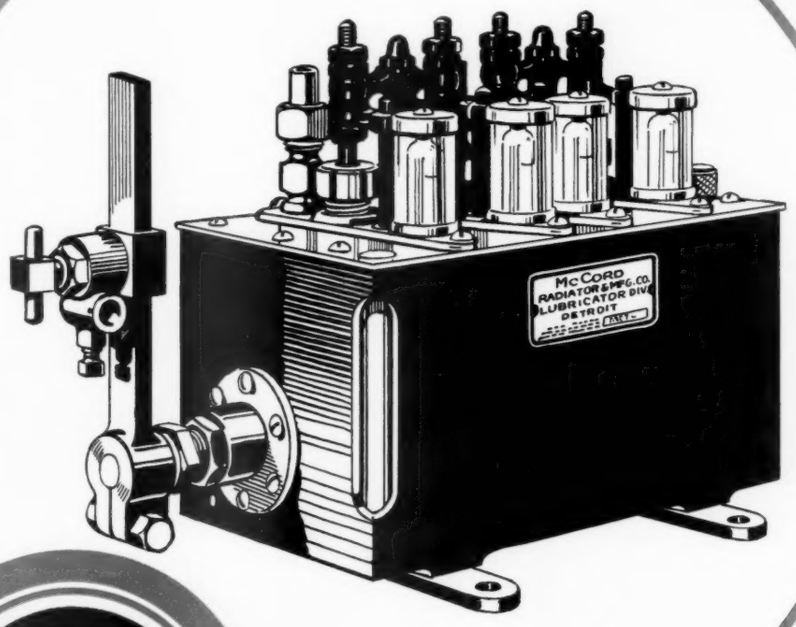
Specify McCord Lubricators on new purchases and order them for your present equipment.

Distributed by **THE NATIONAL SUPPLY CO.** All Branches

Lubricator Division **McCORD RADIATOR & MFG. CO.** Detroit, Mich.

McCORD RADIATOR & MFG. CO.
LUBRICATOR DIVISION
Detroit Mich.

Lubricators *the* OIL FIELDS



McCord

DEPENDABILITY
ACCESSABILITY
·ECONOMY·

quired for the production of 350 gallons of gasoline, gravity 90 degrees Baume. The recovery of this quantity of gasoline per 1,000,000 cubic feet results in the removal from the gas of 39,571,500 B.t.u.s. The sample of West Virginia gas which has been referred to has a heating value of 1,167 B.t.u.s per cubic foot. One million cubic feet of this gas is equal to a B.t.u. content of 1,167,000,000. The quotient obtained by dividing the number of heat units recovered in the gasoline by the total number of heat units contained in the natural gas treated, is 3.39 per cent. In other words, in removing 350 gallons of gasoline from 1,000,000 cubic feet of natural gas the heating value has been decreased only 3.39 per cent.

COMPRESSOR PLANT IN FAR NORTH

The compression plant of Royalite Oil Co. of Canada, located 45 miles west of Calgary, Alberta.

Loss in Specific Gravity

One gallon of gasoline, gravity 90 degrees Baume, at 60 degrees Fahrenheit weighs 5.296 pounds. (Table 5, page 63, Circular 57, Bureau of Standards). The weight of 350 gallons is approximately 1,854 pounds.

The natural gas referred to has a specific gravity of 0.6588 (air=1). One cubic foot of air, measured at 60 degrees Fahrenheit and 30 inches mercury, dry, weighs 0.0764 pounds. One million cubic feet of this natural gas weighs approximately 50,320 pounds. In the removal of 350 gallons of gasoline 1,854 pounds have been recovered, thus leaving 48,466 pounds or 991,750 cubic feet. The quotient obtained by dividing 48,466 by this volume gives the weight of 1 cubic foot of natural gas or 0.04893 pounds. This weight divided by the weight of 1 cubic foot of air is the specific gravity of the gas. The quantity is 0.6403. There has therefore been a loss of 0.0185 in the specific gravity of the gas by the removal of 350 gallons from 1,000,000 cubic feet of it.

Practical Considerations

The practical aspects of the effect of the removal of gasoline from natural gas must of necessity be given the consideration which is warranted and apparent.

Unrefined, or raw, natural gas contains variable quantities of vapors of gasoline hydrocarbons and water. The amount of these vapors depends upon (a) origin of gas, (b) pressure of production, and (c) temperature of production. Generally speaking, low pressure and high temperature of production are favorable to increased content of both water and gasoline vapor. As the pressure of production is increased and the temperature is decreased, the gas carries less of these vapors. Temperature and pressure conditions are always subject to great variations in the marketing of natural gas. At one time of the year, namely in summer, conditions of marketing are such as to reduce to a minimum the opportunities for condensation in the pipe lines. In winter these conditions are such as to maximize the opportunities for condensation of both gasoline and water in the transporting and distributing systems. From the beginning of the natural gas industry up to 1913, the year in which the first oil absorption plant for the recovery of gasoline from natural gas was built, practically all of the gasoline which condensed in the various trunk line systems of the country was collected in drips and then blown therefrom and lost or wasted. No one — producer or consumer—derived any benefit or profit from the large volumes of natural gas gasoline thus collected. There was little or no market for such a product and the market which did exist was one which did not make it worth while to save this product, now so valuable. A great natural resource was wasted for a period of approximately 30 years. Conservatively estimated, the annual loss amounted to more than 100,000,000 gallons of gasoline.

Effect on Rubber Gaskets

Unrefined, or raw, natural gas, with its variable content of vapors of gasoline hydrocarbons and water must be delivered to market. In many instances these markets are more than 100 miles from the producing wells. This delivery is effected through gas compressing stations and in high-pressure pipe lines. Many of these high-pressure pipe lines are constructed of lengths of pipe separated from one another by rubber-composition gaskets and couplings. This form of construction of pipe lines is very generally followed and due to conditions under which these pipe line systems must be operated the results have been so satisfactory that the practice is now followed in the building of many of the large new lines. All systems of pipe line construction have their disadvantages. Prior to the practice of recovering gasoline, considerable difficulty was experienced from the condensation of gasoline and water in the pipe line; the gasoline condensate would disintegrate the rubber gaskets, and as a result of this, there were many instances of large losses of gas due to leakage. Large losses of gas were reflected invariably by greatly decreased line pressures. During the winter months water and gasoline would collect in the low parts in the line and, due to the low atmospheric temperature, the water would freeze and in so doing would either cause the pipe line to part or restrict the pipe line so that its capacity for carrying gas would be greatly decreased. Under these conditions of transportation it is evident that the producer would sustain much loss of gas from leakages and blowouts and that the consumer would have less opportunity to enjoy uninterrupted and continuous service. Many large gas producing concerns, in order to make the supply of gas to the public as dependable as possible, under the old conditions, incurred great expense in the care and maintenance of these pipe lines and yet, under the most exacting conditions of supervision and inspection, there could be no guarantee that a large pipe line would not go out of commission on a cold day when the public would most need its supply of natural gas. Installation of gasoline plants has brought the following practical results: (a) It has eliminated gas and gasoline losses incumbent upon production and transportation of natural gas; (b) it has made natural gas service to the public dependable; and (c) it has been an effective means of conserving a natural resource.

More Efficient Fuel

Unrefined, or raw, natural gas cannot be utilized as efficiently and satisfactorily as refined natural gas by the housewife. The vapors of gasoline, which are contained in the natural gas, burn with a highly luminous flame; however, when mixed with the proper amount of air, these burn with a blue flame. The air requirements of gasoline vapor for complete combustion are much greater than the air requirements of the main components of commercial natural gas — methane and ethane. Domestic appliances are generally not carefully adjusted for the efficient and satisfactory use of unrefined natural gas. The net result of which is, that the housewife finds her pots, pans and other cooking utensils blackened and greasy. It is the gasoline vapor in the gas that is at the "root" of the housewife's displeasure.

Refined natural gas, as it is ordinarily used, burns with a snappy, short, intensively hot, blue flame. Unrefined natural gas under the same conditions burns with a longer, lazier, lower-temperature blue flame. Gasoline removal from the gas improves the flame characteristics of natural gas and thus contributes to greater efficiency and satisfaction in utilization.

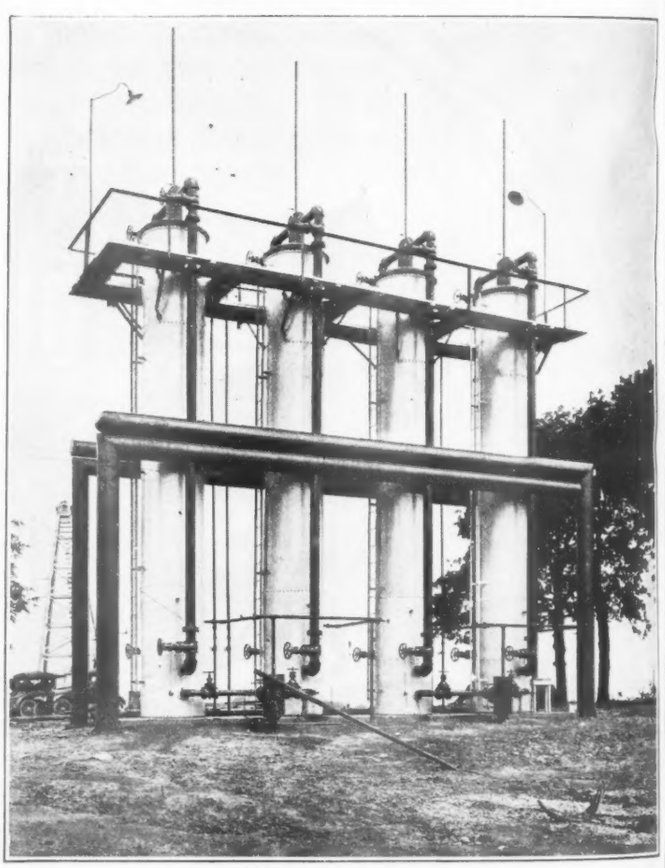
Another phase of the matter under discussion and one worthy of consideration is a comparison of the heating values of municipal supplies of refined natural and manufactured gas.

In Technical Paper 158, United States Bureau of Mines, by G. A. Burrell and I. W. Robertson, the heating values of natural gas collected in 31 cities of the United States are given. The lowest value is 841 B.t.u. per cubic foot and the highest is 1,505 B.t.u. The general average is approximately 1,100 B.t.u.

Manufactured gas as distributed in the United States has a heating value between the limits of 475 and 650 B.t.u. per cubic foot. It is a safe approximation to state that the average heating value of manufactured gas distributed in the United States is 550 B.t.u. Comparatively, the heating value of the average natural supply is two times that of the heating value of the average supply of manufactured gas.

The average price of manufactured gas in the United States is $1 per thousand. With natural gas at 75 cents per thousand you can secure 2.66 times as many heat units for $1 in natural gas as in

ABSORBERS OF GASOLINE PLANT



Absorbers at plant of Oklahoma Eastern Oil Co., showing twin 12-inch gas inlet mains and twin 12-inch gas discharges with parallel twin 6-inch connections to each individual absorber on inlet and discharge lines.

manufactured gas. One heat unit of natural gas has the same value for domestic and industrial purposes as one heat unit of manufactured gas, yet the price of it is less than one-half. In the marketing of other commodities — clothing, flour, sugar, meat, oil, coal, light, power and water—prices and value are not so widely variant.

Northwest Louisiana Gas Company, Inc.

Producers—Transporters—Distributors

of

Natural Gas

General Offices

Slattery Bldg. SHREVEPORT, LA.

Imperial

OXY-ACETYLENE
WELDING and CUTTING EQUIPMENT

Special Equipment for Oil Field Work

Here is an Imperial Welding Torch especially designed for work on pipe lines in oil fields, in wells and for work in congested places. It measures only 14 inches over all, yet it embodies every feature that has made Imperial torches the favorites everywhere.

Write for Complete Catalog

The Imperial Portable Acetylene Generator has proved its worth in the oil fields. It can easily be transported along the line as work progresses and generates pure acetylene gas for welding at a fraction of the cost of gas in cylinders. It is entirely trouble-proof, having no clock-work, weights or pulleys, yet it is fully automatic in operation.

THE IMPERIAL BRASS MFG. CO.
1208 W. Harrison St. Chicago

Distributors

Kansas City Oxygen Gas Co. Kansas City, Mo.
Jos. T. Ryerson & Son Chicago, Ill. and St. Louis, Mo.
Sligo Iron Stove Co. St. Louis, Mo.
Massey Hardware Co. Wichita, Kan.

INSPECTION—TESTS CONSULTATION

Inspection and testing at mills of pipe and casing.

H

Inspection of fabrication of oil storage tanks and structures.

Resident Inspectors at Pipe and Steel Mills

Chemical Cement and Physical Testing Laboratories

ROBERT W. HUNT CO.

ENGINEERS

Dallas Pittsburgh

CHICAGO

New York San Francisco St. Louis

ROTH AND FAUROT

Producers—Transporters—Distributors

..of..

NATURAL GAS

General Offices

INDEPENDENCE, KANSAS

Landis Threading 66-4″ Seamless Steel Bull Plugs Per Hour

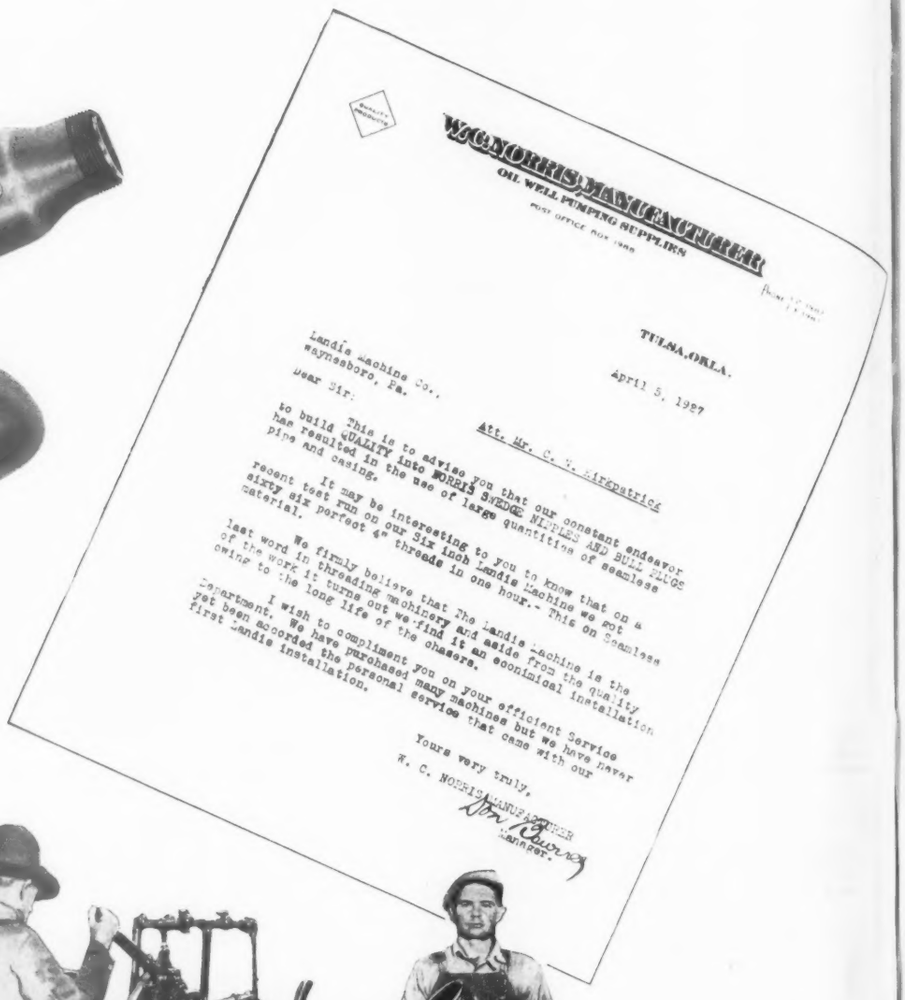
Seamless Steel Tubing and Casing presents a difficult threading problem.

That the tubing is made into Swedge Nipples and Bull Plugs makes the problem harder to solve.

That the Landis Pipe Threading and Cutting Machine successfully threads this material can be learned by reading the letter written by Mr. Don Bowers, Manager of W. C. Norris, largest manufacturers of Swedge Nipples and Bull Plugs in the World.

Whatever your threading problems, Landis will solve them.

Write Now.



W. C. NORRIS, MANUFACTURER
OIL WELL PUMPING SUPPLIES
POST OFFICE BOX 1660

TULSA, OKLA.

April 5, 1927

Landis Machine Co.
Waynesboro, Pa.

Dear Sir:

Att. Mr. C. W. Kirkpatrick

This is to advise you that our constant endeavor to build QUALITY into NORRIS SWEDGE NIPPLES AND BULL PLUGS has resulted in the use of large quantities of seamless pipe and casing.

It may be interesting to you to know that on a recent test run on our Six Inch Landis Machine we got a sixty six perfect 4″ threads in one hour. This on Seamless material.

We firmly believe that the Landis Machine is the last word in threading machinery and aside from the quality of the work it turns out we find it an economical installation owing to the long life of the chasers.

I wish to compliment you on your efficient Service Department. We have purchased many machines but we have never yet been accorded the personal service that came with our first Landis installation.

Yours very truly,
W. C. NORRIS MANUFACTURER
Manager.

LANDIS MACHINE COMPANY, Waynesboro, Penna.

Detroit Office: 5928 Second Blvd.

ENDURANCE

The newspapers said that Lindbergh undertook his glorious adventure *alone*—but, of course, the newspapers are mistaken.

How can a man be *alone* when the hopes, prayers and well wishes of a hundred million admirers accompany him? How can a man be *alone* when the entire civilized world is with him in spirit—thrilling to his thrills, sharing in his fears, glorying in his triumph?

Driving irresistibly on thru the silent, hungry darkness of an Atlantic night, Lindbergh may have been lonely, but certainly he was not *alone.*

Grit, stamina and endurance are marvelous attributes—in oil industry pumps as well as in aviators!

GASO PUMP & BURNER MFG. CO. *Tulsa, Oklahoma*

. . . . . .

Pumps that Last and Last and Last

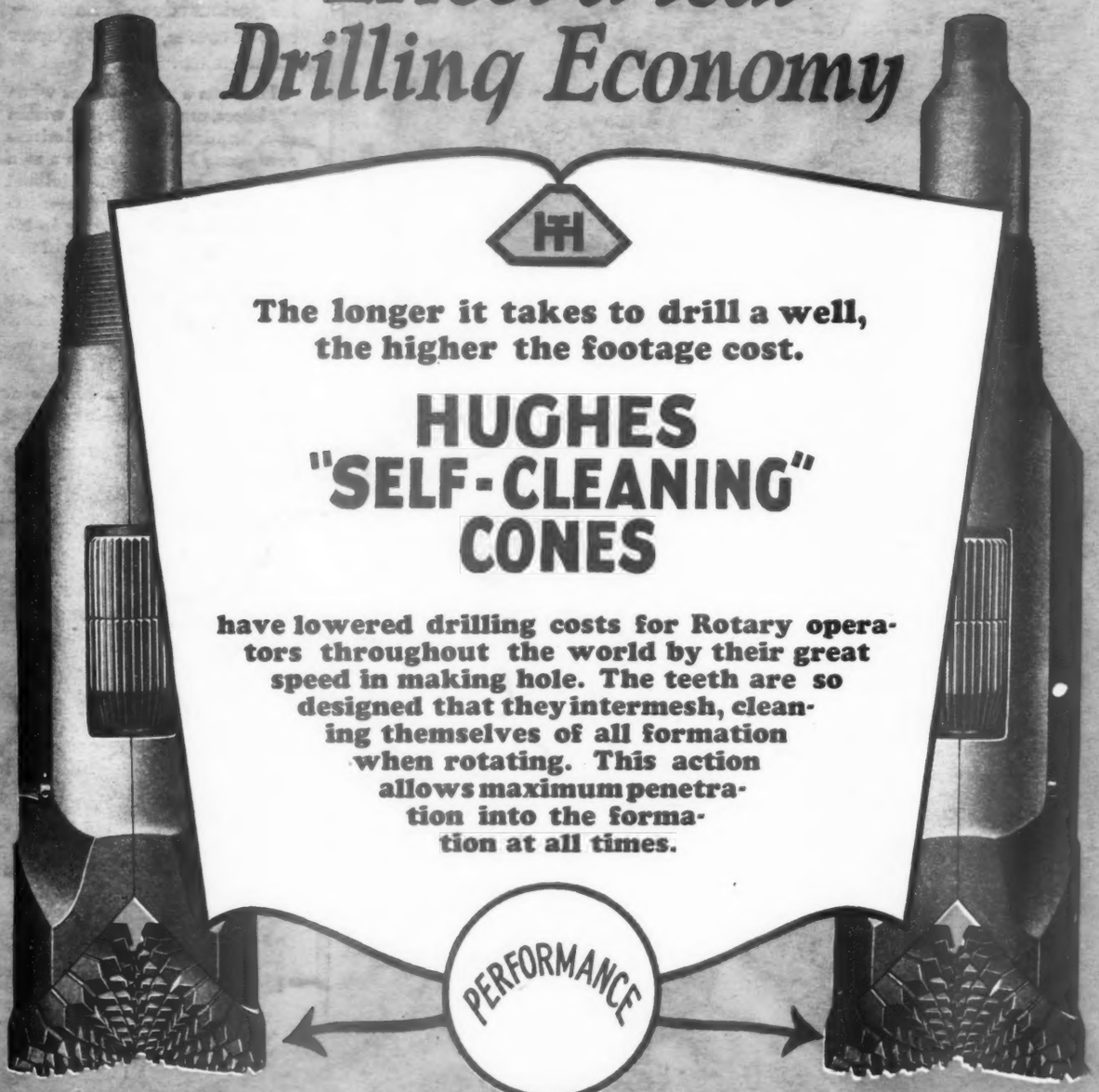
Gaso Walking Beam Pump No. 601—450 to 600 pound pressures. Especially adapted to leases where no pumping power is available. Straight-line pull prolongs life, reduces wear.

Gaso Walking Beam Pump No. 604—Designed for gas or vacuum. Connects to the walking beam with either wood or pipe pittman. Will withstand world of abuse.

GASO PUMPS

for every oil industry need

When you more than DOUBLE the FOOTAGE *per* TOUR *you Effect a real Drilling Economy*



The longer it takes to drill a well, the higher the footage cost.

HUGHES "SELF-CLEANING" CONES

have lowered drilling costs for Rotary operators throughout the world by their great speed in making hole. The teeth are so designed that they intermesh, cleaning themselves of all formation when rotating. This action allows maximum penetration into the formation at all times.

PERFORMANCE

HUGHES TOOL COMPANY

Service Plants
LOS ANGELES, CALIF.
OKLAHOMA CITY, OKLA.

MAIN OFFICE AND PLANT
HOUSTON, TEXAS

Export Office
NEW YORK CITY, N.Y.